

Red Line Extension to Alewife: Before/After Study

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Red Line Extension to Alewife: Before/After Study December, 1987

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EXECUTIVE SUMMARY

In late 1984, the Massachusetts Bay Transportation Authority (MBTA) began operating service on the 3.2-mile Red Line extension between Harvard Square and the Alewife area of Cambridge. The extension features three new stations, a reconstructed Harvard Square Station, a parking garage for 2,200 vehicles at Alewife Station and a re-oriented feeder bus network.

This documents the transportation and land use changes that have occurred in the Northwest corridor during the past few years, and, where possible, identifies links between these changes and the Red Line extension. This is the fourth and final document produced during a two-and-a-half year study process.

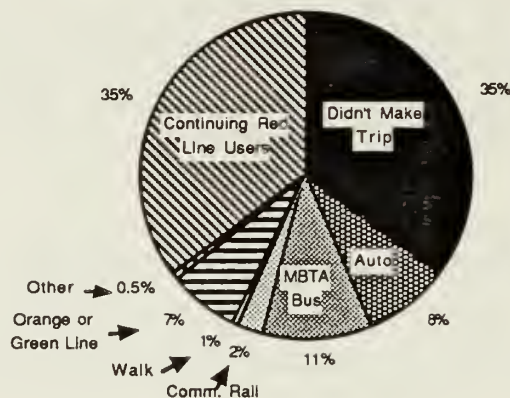
There is a clear link between the extension and the changes in the transportation markets examined. The connection between the extension and land use changes is less clear, and in both cases, the information documented in this report is for the short-term only; long-term impacts on transportation and land use must await future study.

Findings from the study include the following:

- As of the Fall of 1986, daily boardings at the four Northwest extension stations (Harvard through Alewife) totaled 33,500, which was 12,530 more boardings (19,900 more passenger trips) than counted at Harvard Station prior to the extension.
- The increase represents a faster growth rate than that experienced in a similar time span at most other extensions opened by the MBTA since 1970.
- Ridership at the three new Red Line stations is expected to increase further, due to increasing downtown employment, relatively stable downtown parking capacity and the expansion of the Red Line car fleet.
- Riders using Harvard Station are expected to continue to shift to the new stations.
- Many travellers switched to walking, driving or being dropped off to reach the new line, causing a 15 percent decrease in feeder bus ridership.

- Among continuing trip-makers who currently use the new Red Line stations, door-to-door travel time decreased significantly, from 52 to 43 minutes, resulting in a daily travel time savings of 2,200 person-hours.
- Of the users of the three new extension stations, 35 percent are continuing users of the Red Line, 30 percent are new to the Red Line and used to make the same trip by other means, and 35 percent are new to the Red Line, but did not previously make the same trip (see chart).

DERIVATION OF RED LINE EXTENSION RIDERS
ALEWIFE, DAVIS & PORTER



- Among continuing Red Line users, 44 percent changed their mode of access to the line. Park & riding doubled, auto drop off increased three-fold and walking increased by a factor of 2.5. Feeder bus usage is half what it was formerly for this group.
- Among new Red Line users who previously made the same trip by other means, 37 percent formerly used a bus to travel to their destinations, 28 percent drove all the way to their destinations and 22 percent used the Orange or Green Line. All together, two-thirds of this group previously used transit.
- The garage at Alewife Station, as of the Spring of 1987, was used by over 1,700 vehicles per weekday.
 - At its daily peak, the garage was already 75 percent full after only two years of operation.
 - Usage is growing at a steady rate, and it is very likely that the garage will near capacity quite soon.

- Despite large increases in park & riding, overall corridor auto use was reduced in the markets that were measurable.

- Growth in regional daily vehicle-miles-of-travel (VMT) was reduced by 13,800 due to many travellers being diverted from driving altogether, and due to continuing auto users making shorter trips to the new Red Line stations rather than to older Red Line stations or their ultimate destinations.
- Approximately 1,500 daily auto trips were diverted from going into Boston and Cambridge due to travellers switching to the Red Line.

- A majority of Red Line extension users have a car available but use the Red Line instead.

- The characteristic of the extension most pleasing to the users is the appearance of the new stations, with 93 percent of surveyed passengers rating it good to excellent.

- The extension influenced, to some degree, observed land use changes, summarized as follows:

- Large shifts in land use and significant increases in land value occurred in the vicinity of Alewife Station where much land had been vacant or underutilized.
- Davis Square experienced visible economic revitalization.
- In the four station areas, 1.4 million square feet of commercial space was added since 1980 and another 2.5 million square feet has been proposed.

- The extension, as of Spring 1987, had not yet visibly impacted housing prices near new stations.

1 INTRODUCTION

1.1 BACKGROUND

This report is the fourth and final in a series of documents that have been produced for the Alewife Before/After Study. Each of the three preceding documents contained information about various aspects of change resulting from the Red Line extension to Alewife. The first contained preliminary counts of Red Line ridership, feeder bus ridership and vehicular volumes around Alewife Station.¹ The second documented changes in feeder bus operations and ridership.² The third document addressed changes in land use and value in the vicinity of the new stations.³

The objective of this report is to describe the transportation-related changes that occurred in the Red Line Northwest corridor between the Fall of 1984 and the Fall of 1986, to describe corridor land use changes that occurred in recent years, and to document the degree to which the Red Line extension was found to contribute to these changes. Nearly all of the transportation-related information presented in this report is new; such information contained in previous memoranda has either been superseded by, or incorporated into, the data contained herein. The previously written land use report is, however, attached in its entirety as an appendix.

1.2 ORGANIZATION

The body of this report consists of the transportation-related aspects of the before/after study. In the next chapter of this report, the types and sources of data used in this report are described. In Chapter 3, changes in the transportation supply, chiefly the Red Line extension itself, are described. Most of the report is then devoted to describing characteristics of the transportation market. Specifically, Red Line user characteristics are discussed

¹ E.Y. Addante, "Intermediate Findings," CTPS Memorandum, August 21, 1985.

² K.H. Quackenbush, "Feeder Bus Reroutings and Interim Observations," CTPS Memorandum, November 22, 1985.

³ Donald Borchelt, Red Line Extension Land Use Study, MAPC Report, April, 1987.

along with shifts in their travel behavior. Also, characteristics of the feeder bus and park & ride sub-markets, as well as selected traffic volume counts are presented. Chapter 5 contains a summary of findings and Chapter 6 consists of conclusions.

The land use component of the study is contained in the separately-bound volume of appendices. Additional appendices consist of a variety of memoranda and data summaries.

2 DATA COLLECTION/ANALYSIS METHODS

Several kinds of data were collected over the course of this project. These data measure various attributes of the transportation market in the Northwest Corridor before the Red Line was opened for service, soon after it was opened and several months after opening.

Data from different sources were synthesized to the extent possible for purposes of analysis and presentation. For instance, questionnaire results were expanded based on boarding counts taken the same day. In some instances, however, data from two different sources could not be reconciled and these instances are noted.

Overall, the data collection phase of the project was quite successful; nearly all of the information gathered is reliable and useful. However, there are two weak points in the data and these should be noted at the outset. First, the feeder bus counts collected after the opening of the Red Line are pointcheck counts instead of ridecheck counts. Since pointcheck counts only measure the load on a bus at a given point, it is often difficult to infer what the boardings along the entire length of the route are, especially when the route has been re-routed, thereby changing the relationship between loads and boardings. Most "after" feeder bus boardings presented in this report are estimated from pointcheck counts.

Another weak point is the survey questionnaire information for Harvard Station. Surveying efforts focussed on the three new stations and spot surveying was performed at Harvard Station due to the expectation that the extension would not significantly affect travel behavior of boarders there. Even still, a larger than achieved sample size was planned, and the results for Harvard Station, while good at an overall level, tend to become unstable when used at a finer level. For instance, the data accurately represent the mode of access to Harvard, but not the specific feeder bus route for those who use that access mode.

Following, are the major categories of data collected and used in this study:

2.1 QUESTIONNAIRE DATA

Boarding passengers at the four Red Line extension stations were surveyed on April 16 and 17, 1986, between the hours of 6:30 am and 6:30 pm.⁴ The surveying was accomplished by handing passengers a questionnaire that could be mailed back to CTPS. Appendix D consists of a questionnaire form. The sample sizes achieved at Alewife, Davis and Porter Stations were quite good, as shown by Table 2-1.

Table 2-1

<u>Boarding Station</u>	<u>Sample Size</u>
Alewife	973
Davis	748
Porter	498
Harvard	178

As noted above, the sample size achieved at Harvard was lower than the others and, therefore, the data for that station are less versatile.

The questionnaire elicited information about current and past travel behavior, characteristics of the user and of the trip being made, and attitudes towards various attributes of Red Line service. The responses were expanded using boarding counts taken at the same time.

2.2 RAPID TRANSIT COUNTS

MBTA checkers counted passengers boarding at the Red Line extension stations, as well as at Lechmere and Sullivan stations, several times before and since the extension opened. The counts were usually done either for a 20-hour period covering most of the service day or for the three-hour AM peak period.

In the analysis of Red Line boardings trends, these direct counts were supplemented with counts that were derived from revenue obtained at the stations. The revenue information was provided by the MBTA Revenue Department.

⁴ The term "Red Line extension", as used herein, refers to the rebuilt Harvard Station as well as to the three new stations, except where specifically noted.

2.3 FEEDER BUS COUNTS

Ridechecks were performed on all Northwest Corridor buses as part of the Northwest Corridor Bus Study done by Cambridge Systematics, Inc. for the MBTA.⁵ Boardings obtained from these Fall, 1983 ridechecks were used to represent the "before" market of feeder bus users.

As noted previously, the only "after" data available for these bus routes were MBTA pointcheck data which show the loads on buses at specific stops along their routes at various points in time. "After" boardings were estimated from these load counts. These estimates are good, but by definition, not as accurate as actual boardings, gleaned from "after" ridechecks, would have been.

2.4. GARAGE COUNTS

The MBTA has, since Alewife Station opened, recorded the number of vehicles using the parking garage there.

2.5 LICENSE PLATE SURVEYS

License plate numbers of vehicles parked at Lechmere and Sullivan Stations were recorded once before and twice after the opening of Alewife Station. Those of vehicles parked at Alewife Station were recorded once.⁶ The license numbers were then matched to towns using Registry of Motor Vehicle files.

These data were collected in order to track possible shifting in park & riding resulting from the Red Line opening, and to identify the market areas of the three stations.

2.6 TRAFFIC VOLUME COUNTS

Traffic volumes in the vicinity of Alewife Station and Harvard Square were recorded three times: once before the opening of Alewife Station and twice afterwards.⁷ The second count was taken prior to the completion of the interim access

⁵ See Cambridge Systematics, Inc., et. al., Northwest Corridor Service Study, January, 1985.

⁶ Count Dates: Lechmere and Sullivan, December 1984, March 1985 and October 1986; Alewife, November 1986.

⁷ Count Dates: Alewife vicinity, March 1985, November 1985 and October 1986; Harvard Square vicinity, same as Alewife plus December 1984.

ramps between the garage and the Route 2/Alewife Brook Parkway intersection, and the third was taken after the ramps were open.

Each of the three count episodes consisted of two types of counts. Machine counts were recorded by the MDPW at nine locations for three days, 24 hours per day. Manual turning counts were conducted by CTPS at the intersections of Route 2/Alewife Brook Parkway and Rindge Avenue/Cambridge Park Drive/Alewife Brook Parkway in the morning and afternoon peak periods. In addition, in the third count episode, CTPS counted the number of vehicles entering and exiting the Alewife Station garage, by direction, in the peak periods.

3 TRANSPORTATION SUPPLY

The major change to transit service in the Northwest corridor was, of course, to the Red Line itself. However, the feeder bus network was also changed and park & ride capacity was added. The following paragraphs describe all of these changes in public transportation supply, as well as the impact that the changes had on MBTA operating costs and revenues.

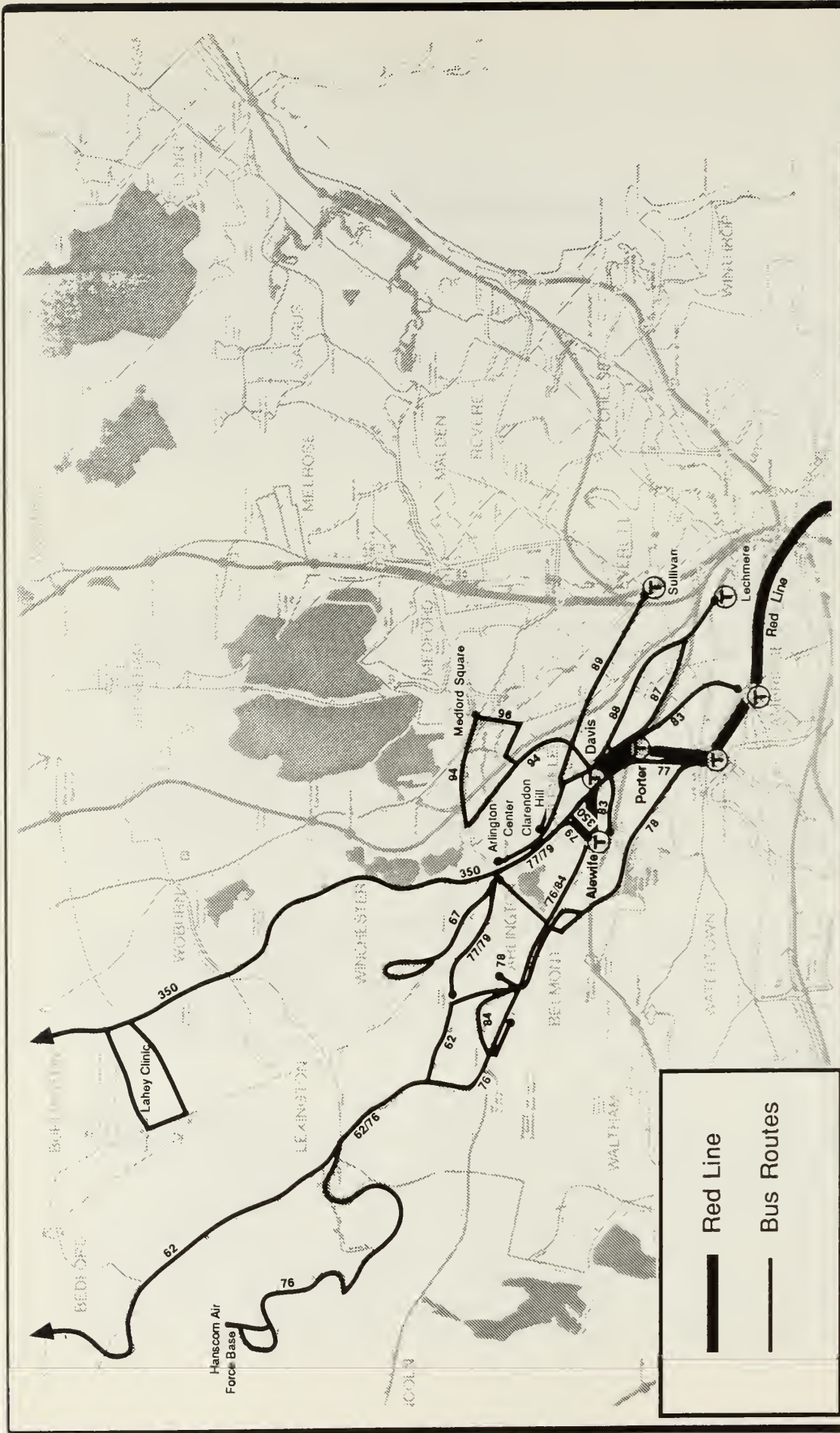
3.1 CHANGES TO THE RED LINE

The Red Line extension consists of 5.5 miles of rail rapid transit between Harvard Square, Cambridge and the Alewife area at the borders of Cambridge, Arlington and Belmont. As part of the extension project, Harvard Station was completely rebuilt and three new stations were constructed. (Refer to Figure 3-1)

The new Harvard Station, opened in September 1983, has longer passenger platforms than the old, is capable of serving higher volumes of passengers through its three entrances and incorporates a new bus tunnel for the several bus routes that connect to the Red Line there.

Porter and Davis Stations, opened in December 1984, provide direct rapid transit service to North Cambridge and West and Central Somerville. These are compact and densely settled areas, so many people are within walking distance of the stations. Wider access to the Red Line is provided by MBTA bus routes that connect to both stations from Arlington, Medford and other towns.

Alewife Station, opened in March 1985, is located at the intersection of Route 2 (the Concord Turnpike) and Alewife Brook Parkway in Northwest Cambridge. Due to its location on a heavily travelled portion of the highway network, it provides access to rapid transit service to a geographically wide market area. The station is located at the borders of Belmont and Arlington, providing residents of those two towns with ready access to rapid transit. In addition, six MBTA bus routes feed into the station, enhancing access to the Red Line for residents of these and other towns further away.



CTPS

FIGURE

3-1

Bus Routings - After Alewife Extension
(Fall 1986)

Alewife Before/After Study

December 1987

The frequency of Red Line service remained constant before and after the extension. As of the Fall, 1986 timetable, Red Line extension weekday service was operated with four-car trains on four-minute peak period and six-minute midday headways. At night, two-car trains were operated on variable headways. Saturday service consisted of four-car trains on five-minute headways, and Sunday service, of two-car trains on six-minute headways. Typically, Braintree-bound trains alternate with those bound for Ashmont.

3.2 CHANGES TO THE FEEDER BUS NETWORK

3.2.1 Overall Changes

In the Fall of 1983, Cambridge Systematics, Inc. analyzed MBTA bus routes in the Northwest Corridor to determine how best to modify them in response to the then impending Red Line extension. (Figure 3-2 shows the "before" bus network.) The resulting report provided the basis for the design and operation of current bus service in the corridor.⁸

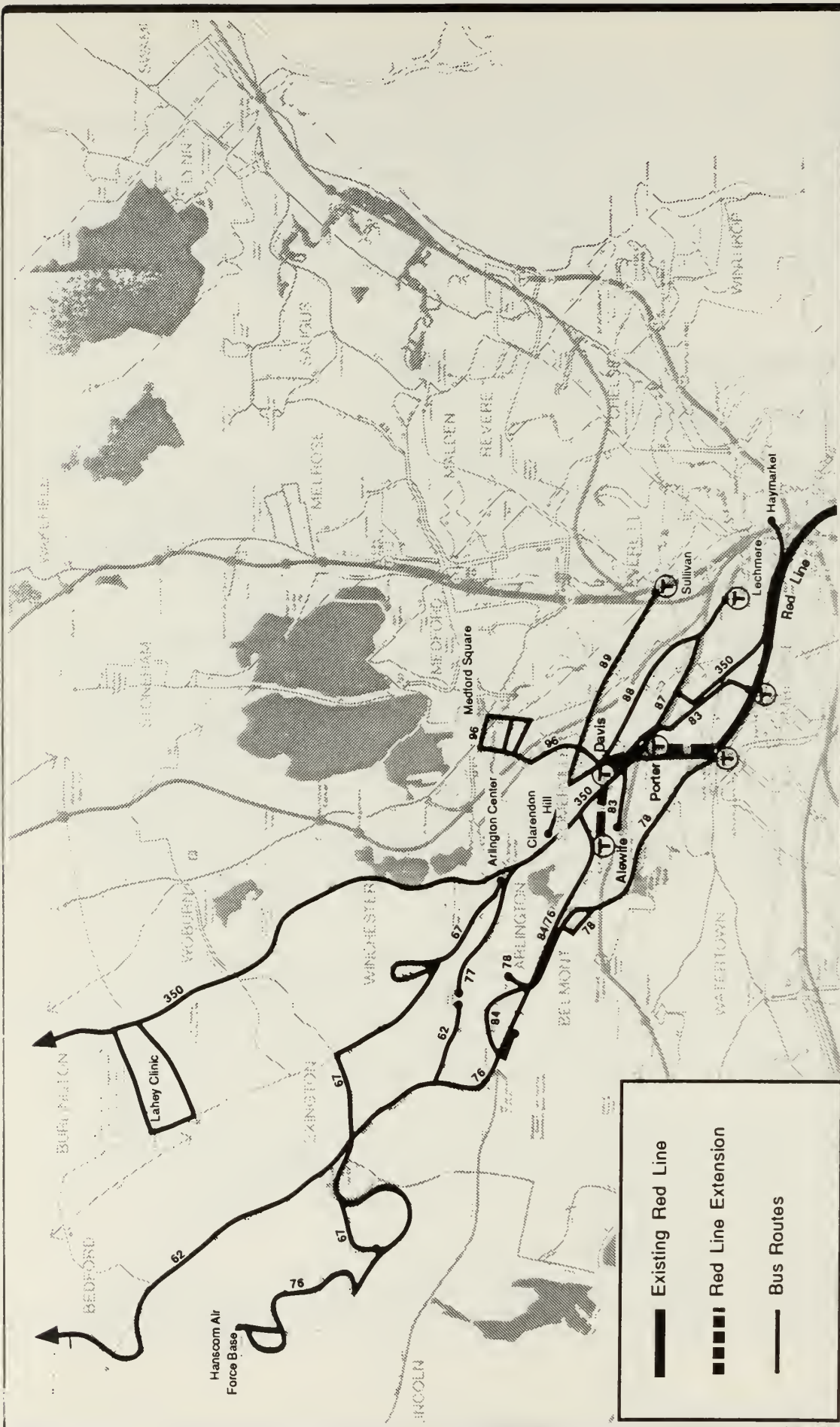
The "before" and "after" changes, for the fifteen routes impacted by the extension, can be divided into four categories.⁹ First, the most significant change to feeder bus service was the re-routing of five existing routes into Alewife Station in 1985. Local Routes 62 and 67 which had terminated at Arlington Heights and Arlington Center, respectively, were re-routed in June. Routes 76 and 84, which had terminated in Harvard Square, were also re-routed in June. In September, the inner terminal of express Route 350 was changed from Haymarket Station to Alewife Station. Service frequency on all five routes was increased after re-routing.

In addition to these re-routings, two new routes were instituted in the corridor. Route 79, essentially a variation of Route 77, was instituted in the Winter of 1985/86. It connects Arlington Heights at its outer end to Alewife Station at its inner. Route 94, begun in the Spring of 1985 operates between West Medford and Davis Station.

The third category of change involved the levels of service on existing routes. Due to passengers diverting to the Red Line extension, service on five bus routes - 77, 77A, 83, 88 and 89 - was reduced. An additional reason for

⁸ Cambridge Systematics, Inc. op.cit.

⁹ The fifteen routes identified as having been impacted by (or created in conjunction with) the extension are: 62, 67, 76, 77, 77A, 78, 79, 83, 84, 87, 88, 89, 94, 96 and 350.



CTPS	FIGURE 3-2
Bus Routings - Before Alewife Extension (Fall 1984)	
Alewife Before/After Study	December 1987

reducing service on Route 77 was the diversion of passengers to the new Route 79.

The fourth category of change to bus routes consisted of re-routings at the outer ends of some routes. Route 76 was deviated to provide more circulation at the Hanscom Air Force Base. The outer end of Route 84 was transformed into a one-way loop and the Lexington portion of Route 67 was deleted. These are all routes whose inner terminals were changed to Alewife Station. Two routes whose inner terminals were left unchanged were also modified at their outer ends. Route 78, operating between Park Circle, Arlington and Harvard Square was changed slightly, and Route 87, which connects with the Red Line at Davis Station was extended from Clarendon Hill in Somerville to Arlington Center.

3.2.2 Changes in Bus Traffic

Bus route changes can also be described from a traffic perspective. That is, the re-routings, new routings and changes in levels of service obviously affect the number of bus vehicle-trips in several areas.

Overall, the total number of round-trip bus trips in the corridor increased from 694 to 762 or by about 10%. At Alewife, the re-routing of Routes 62, 67, 76, 84 and 350, as well as the provision of new service on Route 79, led to 210 daily round-trip bus trips travelling into and out of the station along area roads. The first four routes approach the Station on Route 2; Routes 79 and 350 approach it on Alewife Brook Parkway.

Offsetting the increased bus traffic at Alewife are the reduced bus trips elsewhere. Prior to the opening of the Red Line, most of the corridor bus trips (442) had one end in Harvard Square. However, since the re-routings of Routes 76 and 84 to Alewife Station, and the reductions in service on Routes 77 and 96, the number of trips into and out of Harvard Square decreased by 28% to 320. In addition to these reductions, Arlington Heights experiences 21 fewer bus trips per day and Arlington Center, 24 fewer. Haymarket Square experiences 33 fewer bus trips per day.

3.3 CHANGES IN PARKING FACILITIES

Accompanying the changes to the Northwest corridor transit system itself, was a change in the supply of parking capacity available for park & ride patrons of the Red Line. That is, as part of Alewife Station, which is located at the junction of two major arterial highways, a 2200 car parking garage was constructed.

The intersection of Route 2/Alewife Brook Parkway was reconfigured from a rotary to a signalized intersection in the Fall of 1986. As part of that reconfiguration, ramps were built between the intersection and the parking garage. One can drive directly from Route 2 eastbound to the garage without passing through the intersection. Similarly, one can exit the garage onto a ramp which goes directly into the intersection. Formerly, one had to also travel through the signalized Cambridge Park Drive/Alewife Brook Parkway intersection in order to travel north on the Parkway or west on Route 2 (see Figure 3-3).

3.4 CHANGES IN MBTA OPERATING COSTS AND REVENUES

The extension of the Red Line increased operating costs and passenger revenues on the line, and the reconfiguration of the feeder bus network also had an impact on costs and revenues. This section addresses the combined effect of these two actions. (See Table 3-1 for all cost and revenue information.)

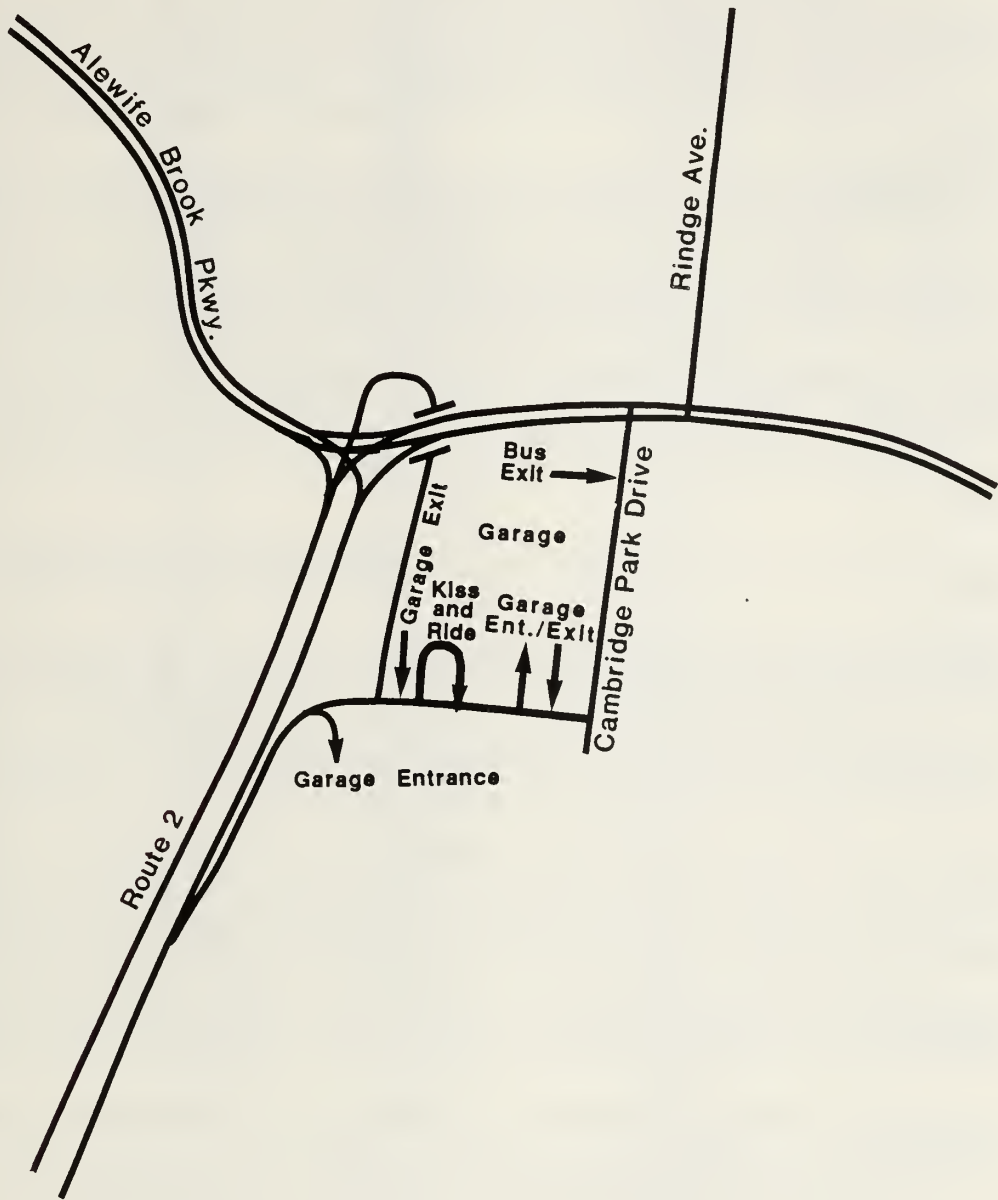
3.4.1 Impact on Variable Operating Costs

As noted previously, the level of service on many feeder bus routes was increased concurrent with their re-routing into Alewife Station. On Routes 62, 67, 76 and 84, service was increased by 59 percent, from a daily total of 66 trips per day to 105. On the fifteen routes combined, after accounting for service reductions on some, the net number of weekday round trips increased by eight percent from 757 to 817. However, due to shorter alignments on routes re-routed into Alewife Station, vehicle service hours remained essentially the same (up 0.4 percent), while vehicle service miles decreased by 5.5 percent. In addition, the peak vehicle requirement for the fifteen routes declined by 12 vehicles from 85 to 73.

The overall impact of these changes on daily bus variable operating costs was minor: costs decreased 1.4 percent (in \$1984) from \$37,400 to \$36,800. Daily variable operating costs for the Red Line extension are approximately \$16,300 per weekday (Fall 1986 service level, \$1984). Therefore, total Fall 1986 variable operating costs for the fifteen bus routes and the Red Line extension combined, in \$1984, is \$53,100, or 42 percent more than the prior bus-only costs.

3.4.2 Impact on Farebox Revenues

Prior to the opening of the Red Line extension, there were 47,500 daily passenger trips on the fifteen (thirteen then) bus routes of interest. In April 1986, a year after all stations were open, there were 40,200 daily passenger



Alewife Before/After Study

December 1987

Roadway Geometrics in Vicinity of
Alewife Station/Garage

CTPS

FIGURE

3-3

Table 3-1
Summary of Operating Costs, Revenues and Deficit
(Average Weekday)

		Operating Cost	Farebox Revenue	Revenue/ Cost Ratio
RED LINE EXT	Before	\$0	\$0	-
	After	\$16,290	\$10,150	0.62
	% Change	NA	NA	NA
Route 62	Before	\$960	\$230	0.24
	After	\$1,730	\$400	0.23
	% Change	80.9%	70.4%	-4.2%
Route 67	Before	\$460	\$60	0.13
	After	\$870	\$260	0.30
	% Change	88.8%	356.6%	130.7%
Route 76	Before	\$2,050	\$590	0.29
	After	\$1,720	\$410	0.24
	% Change	-16.1%	-31.0%	-17.3%
Route 77	Before	\$9,030	\$5,010	0.55
	After	\$7,080	\$3,510	0.50
	% Change	-21.5%	-30.0%	-9.1%
Route 77A	Before	\$2,420	\$1,560	0.64
	After	\$1,820	\$590	0.32
	% Change	-25.0%	-62.0%	-50%
Route 78	Before	\$2,120	\$720	0.34
	After	\$2,290	\$560	0.24
	% Change	7.7%	-23.0%	-29.4%
Route 79	Before	\$0	\$0	-
	After	\$2,810	\$710	0.25
	% Change	NA	NA	NA
Route 83	Before	\$2,290	\$1,490	0.65
	After	\$2,450	\$1,010	0.41
	% Change	7.1%	-32.0%	-36.9%
Route 84	Before	\$1,450	\$360	0.25
	After	\$1,210	\$370	0.31
	% Change	-16.7%	3.0%	24.0%
Route 87	Before	\$2,720	\$1,190	0.44
	After	\$2,800	\$1,390	0.50
	% Change	3.0%	16.6%	13.6%
Route 88	Before	\$3,430	\$1,830	0.53
	After	\$2,490	\$1,640	0.66
	% Change	-27.5%	-10.4%	24.5%
Route 89	Before	\$2,660	\$1,730	0.65
	After	\$2,400	\$1,570	0.65
	% Change	-9.6%	-8.7%	0.0%
Route 94	Before	\$0	\$0	-
	After	\$2,040	\$510	0.25
	% Change	NA	NA	NA
Route 96	Before	\$3,980	\$1,990	0.50
	After	\$2,260	\$1,060	0.47
	% Change	-43.3%	-47.1%	-6.0%
Route 350	Before	\$3,830	\$1,070	0.28
	After	\$2,880	\$630	0.22
	% Change	-24.8%	-40.8%	-21.4%
TOTAL (Red Line plus Bus Service)	Before	\$37,390	\$17,820	0.48
	After	\$53,130	\$24,750	0.47
	% Change	42.1%	38.7%	-2.1%

trips on these buses. The Red Line extension, including Harvard Station, had 19,900 more daily passenger trips than at Harvard Station alone in November 1984. Thus, "after" passenger trips on the services of interest totalled 60,100.

The increased patronage caused total revenue to increase from \$17,800 to \$24,800 on the services of interest.¹⁰ However, bus revenue alone declined along with bus ridership. The latter decreased because more riders were diverted to the Red Line than have so far been attracted by the improved feeder service.

The decline in bus revenue (18.4 percent) exceeded the decline in bus ridership (15.5 percent) due to the shortening of Routes 76 and 350 from five to four zone routes, which reduced the number of zones travelled by most riders and the total fare collected. This was partially offset by the lengthening of Route 62 (from Arlington Heights to Alewife), but overall, the combined average fare on the routes examined declined from 37.5 cents to 36.4 cents. However, for bus and rail trips combined, the average fare collected increased from 37.5 cents to 41.2 cents, due to the higher Red Line fare.

3.4.3 Impact on Revenue/Cost

Since the increase in variable operating costs exceeded the increase in farebox revenues, the MBTA's operating deficit increased as a result of the Alewife extension. This is not surprising; most transit service extensions would have this impact. By route, bus operating deficits before and after the Red Line extension are as shown in Figure 3-4.

More significantly, Table 3-1 shows the ratio of passenger revenue to variable operating cost (R/C ratio) for the bus routes and the Red Line extension. Overall, this ratio remained stable before and after the extension. Prior to the extension, the R/C ratio for the bus routes that existed was .476, and after the extension, the combined R/C ratio for the fifteen bus routes and the extension was .466.

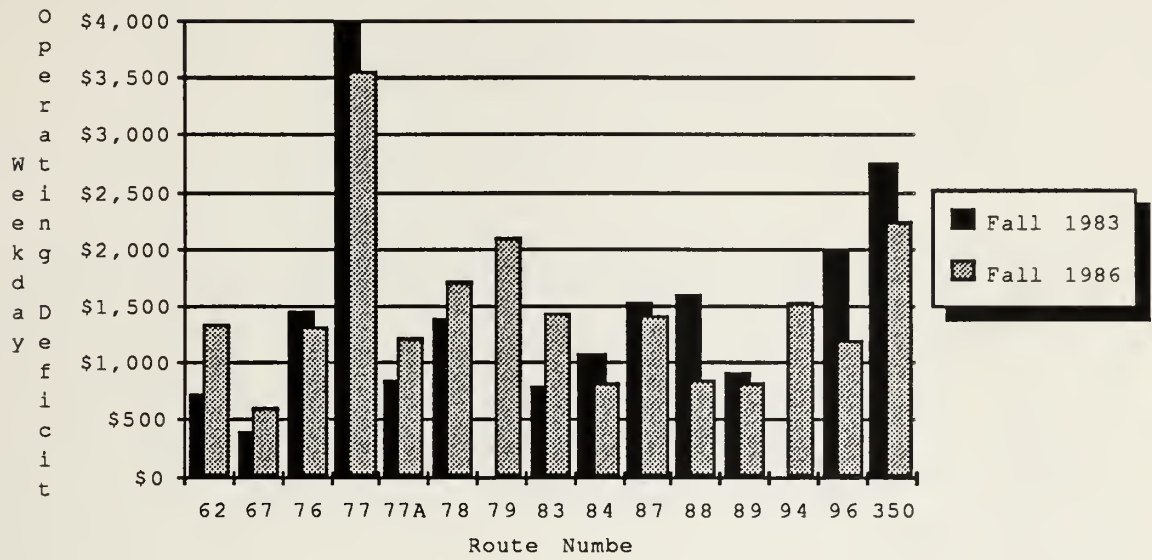
The Red Line extension alone, at .62, compared quite favorably to the 1984 MBTA rapid transit system average of .51.¹¹ Among the thirteen bus routes that existed both before and after the extension, the R/C ratio increased for four of them, decreased for eight and remained constant for two. This is consistent with the revenue decreases cited

¹⁰ The analysis did not include revenue changes on other MBTA services that occurred as a result of riders shifting between those services and the Red Line.

¹¹ 1984 MBTA Annual Report and 1984 UMTA Section 15 data.

above. The "after" R/C ratio for all fifteen bus routes combined was .40, compared to a 1984 MBTA bus system average of .38.

Figure 3-4
Weekday Bus Operating Deficits - Before/After (\$1984)



4 TRANSPORTATION MARKET

This chapter describes characteristics of the Northwest Corridor public transportation market and the changes that occurred in it between the Fall of 1984 and the Fall of 1986. During that interval, the major supply-related factor influencing the market was, of course, the opening of the Red Line extension. However, since this market was also subject to influences independent of the Red Line opening, it is not always clear whether the Red Line alone caused a particular change in travel behavior or trip characteristic. It is safe to assume, though, that the extension, if not always the sole underlying cause of the changes documented, was the strongest one.

The major portion of this chapter is devoted to Red Line extension users, since they make up the primary market of interest. Following that is a discussion of two of the larger sub-markets within this market: travellers who access the Red Line by MBTA feeder bus and by parking & riding. The final portion of this chapter is devoted to a discussion of "before" and "after" traffic volumes at selected locations as they relate to the opening of the extension.

4.1 RAPID TRANSIT MARKET

In the following paragraphs, three major topics are addressed. First, various characteristics of current extension users are presented. These include socio-economic characteristics, characteristics of the trips being made, and various attitudes held by these users. The source of information is the Red Line passenger survey described earlier.

Following this, trends in rapid transit boardings are presented. These focus on the Red Line, but trends at Lechmere and Sullivan Stations are also presented because it was originally estimated that travellers would shift from these stations to the extension. The primary source of this information is the MBTA Scheduling Department.

Finally, shifts in travel behavior that occurred between the Fall of 1984, before the extension was open, and the Fall of 1986, nearly two years after the extension opened, are

presented. This information addresses the effects that the Red Line extension had on the market of all transportation users in the study area who are now Red Line users. The source of this information is, once again, the passenger survey.

4.1.1 Socio-Economic and Trip Characteristics

Four socio-economic characteristics of current Red Line extension riders were measured: auto ownership, auto availability, age and household income. Trip characteristics measured were mode of access to the Red Line, city or town of origin, destination city or town, trip purpose, trip time and frequency of Red Line use. (See Appendix C also.)

The "typical" extension rider, including those who board at Harvard, is 35 years old, lives in Cambridge, works in Boston, uses the Red Line 3 to 4 days a week, has a car available for his or her trip but used the Red Line instead, has a household income in excess of \$30,000, and spends about 44 minutes to complete the trip. As would be expected, however, the characteristics of many riders also vary significantly from these typical values, especially when viewed by boarding station (see Figure 4-2 and Appendix C).

On the basis of auto availability, Red Line extension users have a relatively low level of transit dependency. In excess of 76 percent of them live in households that have at least one car, and 54 percent had a car available for the transit trip they were making when surveyed. New Red Line users and continuing users have about the same level of transit dependency.¹² Among stations, Alewife boarders are the least transit dependent: two-thirds have a car available for their trip, but instead ride the Red Line by choice.

Auto availability for Red Line extension users is much higher than for the market of MBTA bus users in the same

¹² Terms used throughout this memorandum are defined as follows:

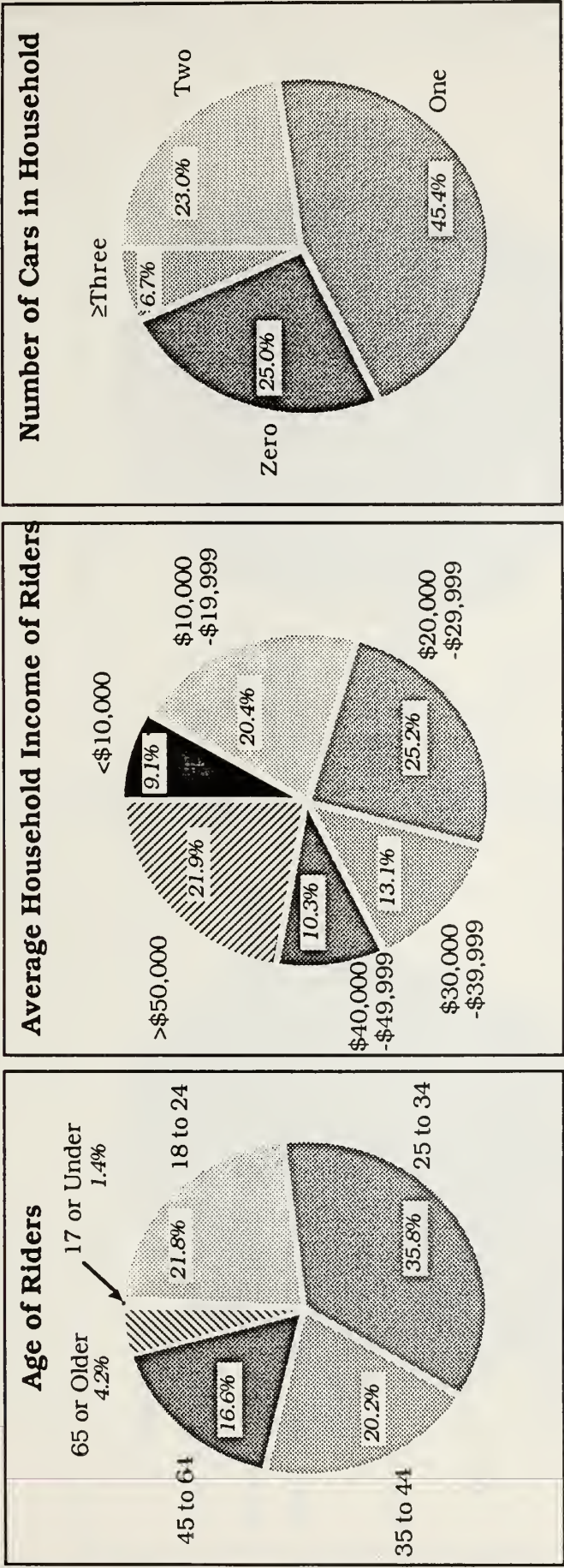
Continuing Red Line user. One who had used the Red Line in late 1984 and had boarded at Harvard, Central, Kendall or Charles.

New Red Line user. One who had not used the Red Line as of late 1984 and who may or may not have made the same trip.

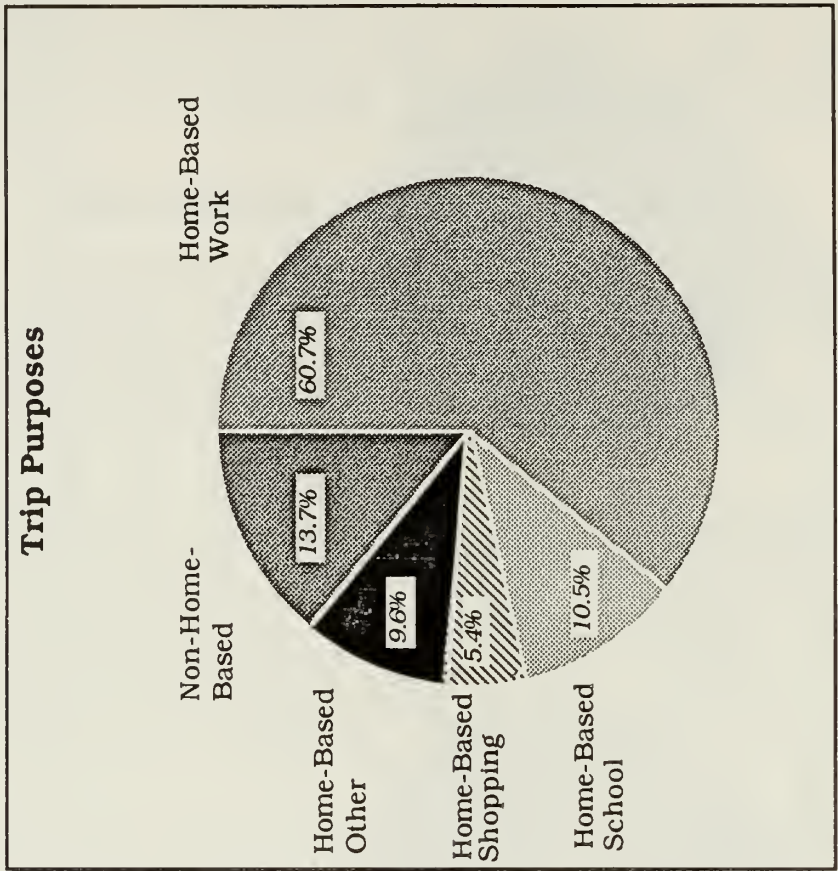
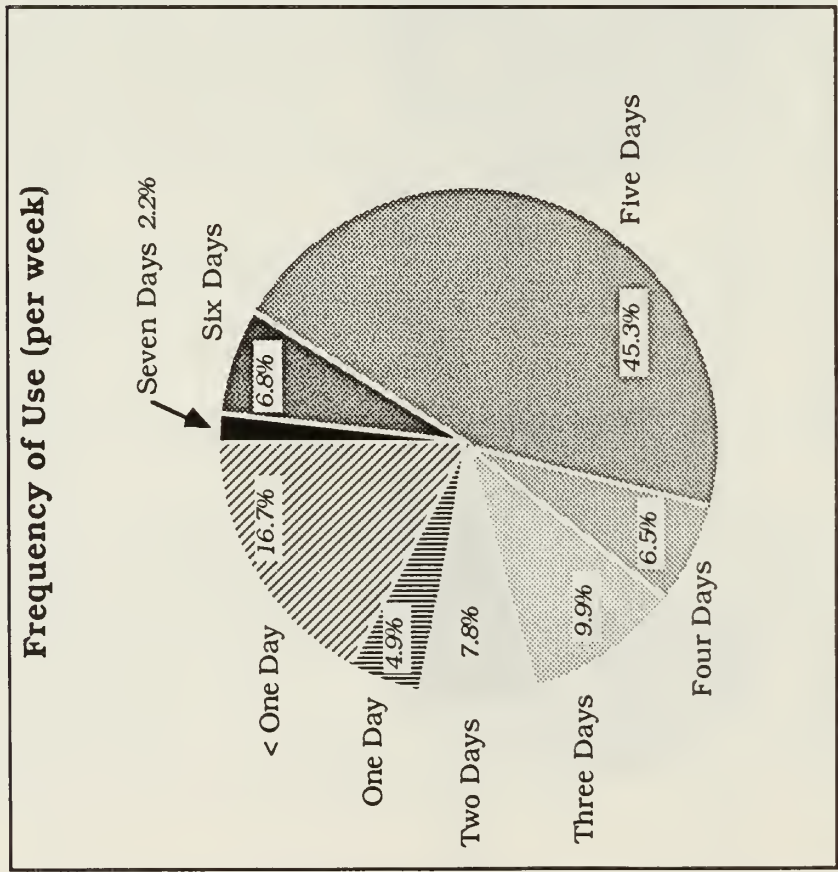
Continuing Trip-maker. One who had previously made the same trip, either by Red Line or by other means.

New Trip-maker. One who did not, by any means, previously make the same trip.

The Same Trip. A previously made trip is considered to be the same trip as is currently being made if the origin and destination are the same as before.



Alewife Before/After Study	CTPS	Selected Socio-Economic Characteristics of Red Line Extension Riders	FIGURE 4-2
			December 1987



Alewife Before/After Study

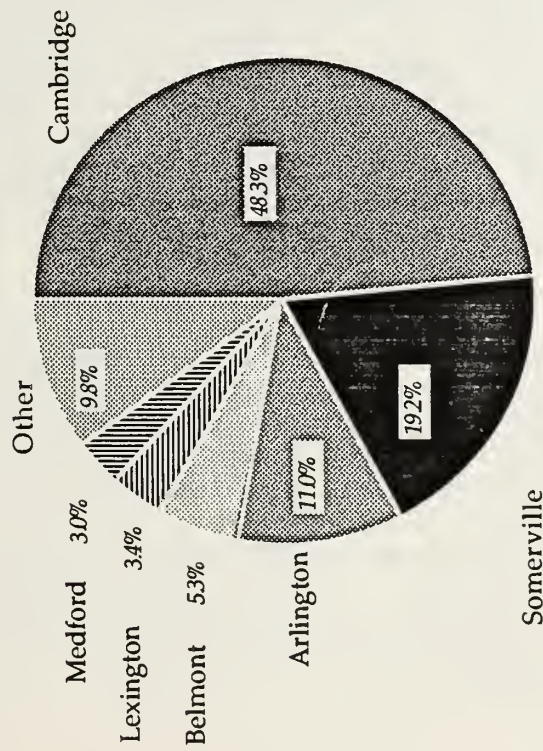
December 1987

Red Line Extension Riders:
Trip Purposes and Number of Days Used per Week

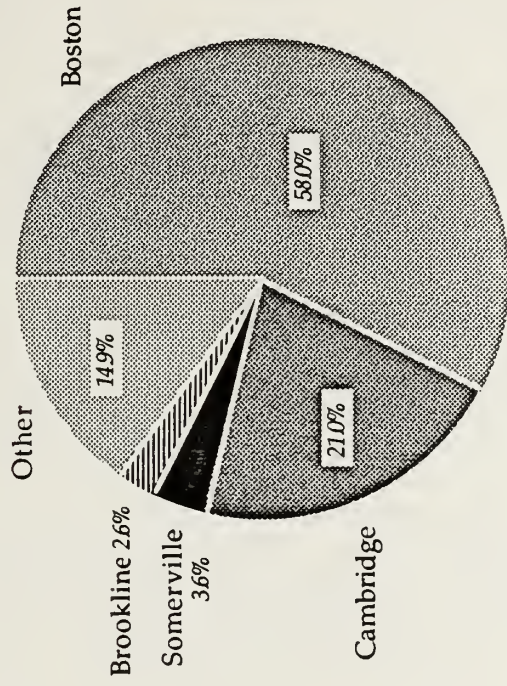
CTPS

FIGURE 4-2
(Cont.)

Origin Cities/Towns



Destination Cities/Towns



Alewife Before/After Study

December 1987

Origin and Destination Cities and Towns
of Red Line Extension Riders

CTPS

FIGURE 4-2
(Cont.)

general geographic area, even though the markets overlap. In recent surveys, it was found that only 28 percent of Northwest Corridor bus riders and 22 percent of Central North bus riders had an automobile available for their trip.¹³ This Red Line/bus market disparity is not surprising, given that many extension users are park & riders and that the portion of them from affluent suburban towns is higher.

Most Red Line extension riders - 58 percent - are between 18 and 34 years old. Thirty-seven percent are 35 to 64, 4.2 percent are 65 or older and only 1.4 percent are under 18. Boarders at Alewife Station are, on average, older than those at the other three stations.

The household income of Red Line extension riders is significantly higher than that of bus riders in the same general area. The household income of 45 percent of the former group is greater than \$30,000, while that of only 28 percent of all Northwest Corridor and 20 percent of Central North Bus riders exceeded \$30,000 when surveyed. Part of this difference is attributable to inflation, but much is attributable to the relative affluence of Alewife Station boarders, large numbers of whom are from suburbs along Route 2. Sixty-five percent of these travellers have a household income over \$30,000, and 35 percent have a household income exceeding \$50,000.

While Alewife boarders are the most affluent of the extension riders, Davis and Porter boarders are the least affluent and the most transit dependent. At Davis, most riders are from Somerville (68 percent), have a household income of less than \$30,000 (65 percent) and did not have a car available for their trip (51 percent). At Porter, most riders are from Cambridge or Somerville (51 percent and 35 percent, respectively), also have household incomes less than \$30,000 (62 percent) and did not have a car available for their trip (56 percent). Both Davis and Porter Stations have higher than average proportions of student riders (12 percent, and 18 percent, versus an average of 11 percent for the extension as a whole).

Most users of Davis and Porter Stations walk to the Red Line (66 percent at Davis; 76 percent at Porter) or take an MBTA bus (21 percent and 13 percent, respectively). Fewer than 12 percent arrive at either station by automobile (driving alone or with others, or dropped off). At Alewife

¹³ The survey of Northwest Corridor bus riders was done by Cambridge Systematics, Inc. in the Fall of 1983. That for the Central North corridor, which consists largely of Cambridge, Somerville and Allston/Brighton, was done by CTPS in the Spring of 1985.

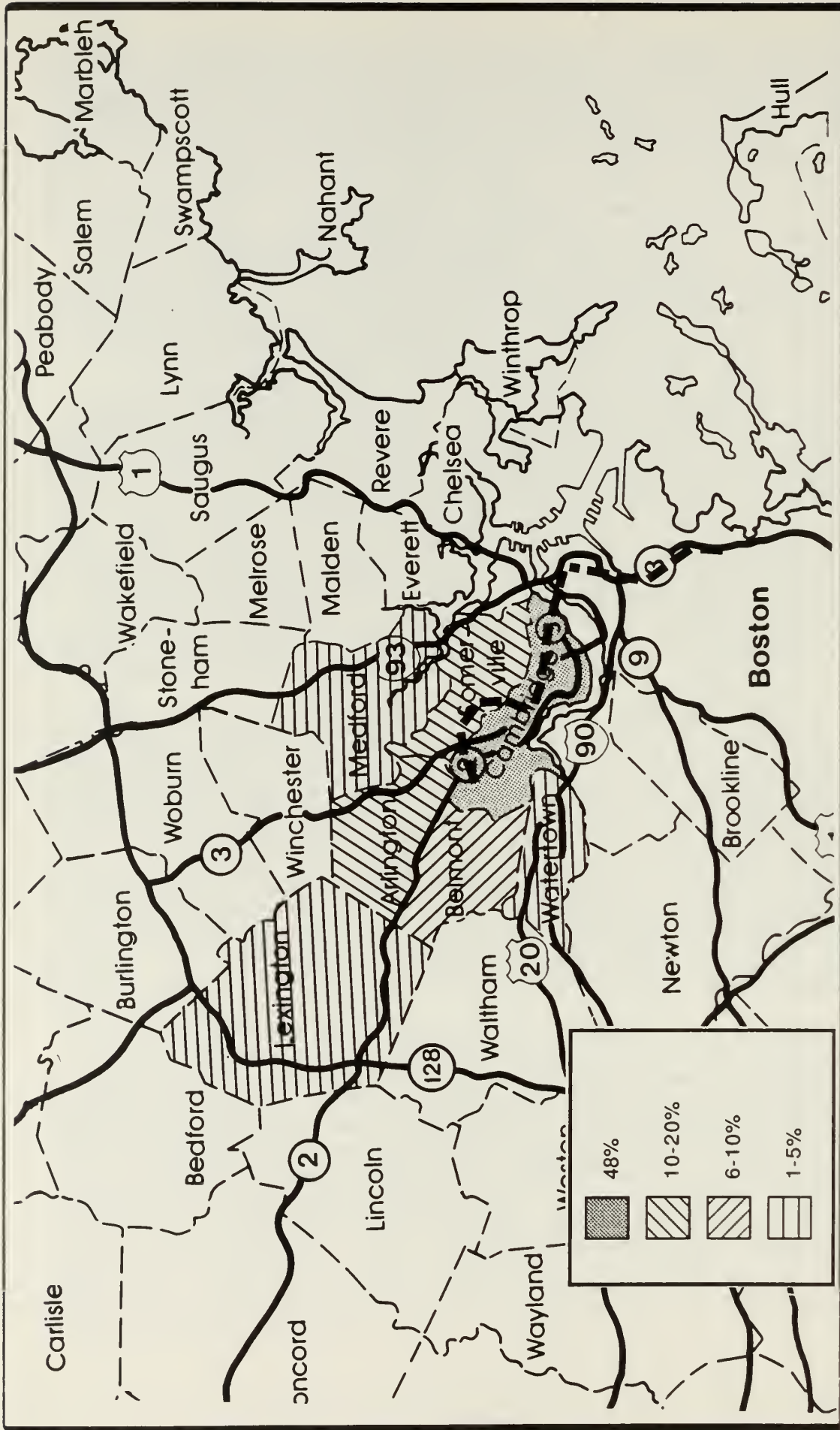
Station, the largest group of travellers does arrive by automobile, with 38 percent driving alone or with others and 10 percent being dropped off. Thirty-six percent use feeder buses. Most travellers arrive at Harvard Station by walking (61 percent), and secondarily by bus (28 percent).

While the greatest number of inbound trips originate in Cambridge (48 percent), the Red Line extension also attracts trips from 54 other cities and towns in Massachusetts. Before the extension, most Red Line users of Harvard Station originated in Cambridge, Somerville, Arlington, Belmont, and Lexington. This continued to be the case for users of the extension after its opening, but many travellers who had previously been making their trips by other means were attracted to the Red Line from Acton (85), Bedford (70), Burlington (85), Concord (190), Lincoln (90), Medford (345), and Winchester (115). In addition, scattered trips were attracted from a number of towns beyond Interstate 495 as far away as Pepperell and Groton (refer to Figure 4-3).

The overwhelming majority of inbound extension trips are bound for Boston or Cambridge: fifty-eight percent to the former and 21 percent to the latter. Of those bound for Boston, 35 percent are bound for the the downtown/Back Bay area. Eighty-five percent of the trips are bound for either Boston, Cambridge, Somerville or Brookline. The remaining 15 percent are bound for a wide array of towns.

At Harvard Station, fewer trips are for work purposes (56.6 percent versus 60.7 to 68.5 percent for the other three stations), while many more trips are made by occasional users (almost half of all Harvard boarders use the Red Line three days or less per week). Much of this difference is presumably due to the high student population at this station. However, in spite of the large student population in and around Harvard Square, other statistics such as household income, auto availability, and age of Harvard boarders show little variation from those of riders at the other stations.

In general, new users use the Red Line extension for the same reasons that continuing users do. As shown in Table 4-1, just under one-half of all users cited the avoidance of parking and/or traffic as a major reason for using the Red Line. Twenty-eight percent said that the extension was less expensive than driving, and 19 percent said that using the Red Line reduced their travel time. The only significant difference between new and continuing riders was in the area of comfort, with many more new riders citing it as a factor (17 percent versus 10 percent).



CTPS

FIGURE
4-3

Cities/Towns of Origin
of Red Line Extension Riders
(Spring 1986)

Alewife Before/After Study

December 1987

Table 4-1
Reasons for Using Red Line/Changes Made Due to Extension

	Percent of Survey Respondents Making Comment ¹⁴		
	Continuing Users	New Users	Both Groups
<u>Reasons for Using Red Line</u>			
To Avoid Parking	48.7%	47.0%	47.8%
To Avoid Traffic	45.1%	47.0%	46.1%
No Auto Available	38.5%	36.9%	37.7%
Lower Cost than Driving	28.6%	28.1%	28.3%
Less Travel Time	17.3%	21.4%	19.4%
Comfort	9.9%	17.3%	13.8%
To Conserve Gas	12.7%	12.2%	12.4%
Other	8.6%	12.1%	10.5%
<u>Changes Made as a Result of the Red Line Extension</u>			
Did Not Make Any Changes	80.1%	69.8%	75.0%
Change Shopping	5.3%	12.1%	8.9%
Relocate Housing	3.0%	8.0%	5.6%
Change Work Hours	4.6%	2.4%	3.4%
Change Jobs	0.5%	3.8%	2.2%
Sell an Auto	0.3%	0.6%	0.5%
Change Schools	0.5%	0.3%	0.2%
Other	4.6%	3.5%	4.0%

As also shown in Table 4-1, most extension riders - 75 percent - did not make any changes in their home, work or shopping habits as a result of the extension. Nine percent said that they made changes in their shopping habits. Six percent also claimed to have moved as a result of the extension, but based on changes made as a result of other similar service changes, this figure appears high, indicating that the question may have been answered incorrectly by many riders.¹⁵ Overall, new users showed a slightly higher incidence of change than continuing users. Given that some

¹⁴ Survey respondents were asked to check as many responses as applied. As a result, percentages do not total to 100 percent.

¹⁵ Fewer than one percent moved as a result of the Red Line extension to Braintree or the opening of Quincy Adams Station. Some of the difference may be due to the large student population in the Cambridge/Somerville area. Students often move more frequently than do other residents, and many of these moves, which probably would have occurred otherwise, were influenced to some degree by the extension.

of these changes were made in conjunction with the new users' shifting to the Red Line, this is not a surprising finding.

The extension resulted in significant reductions in door-to-door travel times, as shown in Table 4-2. For current Red Line extension riders at the three new stations who previously made the same trip (whether by transit or not), mean travel time decreased by 17 percent from 52 to 43 minutes. These reduced travel times resulted in total savings of 2,200 person-hours per weekday.

Table 4-2
Before and After Travel Times
(in minutes unless otherwise noted)

	<u>Alewife</u>	<u>Davis</u>	<u>Porter</u>	<u>Total</u>
<i>Mean Travel Time</i>				
Before	56	49	48	52
After	51	38	39	43
% Change	-8.9%	-22.5%	-18.8%	-17.3%
<i>Riders Affected</i>	3,595	2,992	2,342	8,929
<i>Daily Travel</i>				
<i>Time Savings (hours)</i>	600	900	700	2,200

4.1.2 Passenger Attitudes

As part of the April 1986 passenger survey, riders were asked to rate the following aspects of Red Line service: the reliability of service, the cleanliness of the trains, the comfort of the ride, whether or not there was adequate room on board, the appearance of the new stations, the helpfulness of MBTA personnel, and the directness of service. With the exception of service reliability and crowding, in excess of 75 percent of all passengers rated these service measures as average or better (see Table 4-3). The new stations were particularly well received, with 93 percent of all riders rating them as good or excellent.

Table 4-3
Passenger Perceptions of Service Quality

	Poor/ <u>Very Poor</u>	<u>Average</u>	Good/ <u>Excellent</u>
Helpfulness of Employees	21.4%	38.4%	40.2%
Appearance of Stations	2.9%	4.4%	92.8%
Room On-Board Trains	29.4%	40.7%	30.0%
Comfort of Ride	18.8%	51.0%	30.2%
Cleanliness of Trains	18.1%	38.0%	44.0%
Reliability of Service	31.2%	33.9%	34.9%
Directness of Service	17.0%	28.4%	54.5%

Seventy-one percent of all survey respondents rated crowding conditions as average or better, and 69 percent rated reliability as average or better. These ratings, while high, are not as high as the other categories; they no doubt reflect the service problems experienced on the Red Line over the past few years and the heavy loads the line carries. However, while the rating of reliability is relatively low, it is an improvement over that given by Red Line riders on the South Shore extension in February 1984. Only 37 percent of those riders rated reliability as average or better, indicating that although problems persist, significant improvements have occurred.

In other comparable areas, the attitudes of Alewife extensions riders were also generally more favorable towards the Red Line than their South Shore extension counterparts, as shown in Table 4-4.

Table 4-4
Comparison of Alewife and South Shore Passenger Ratings

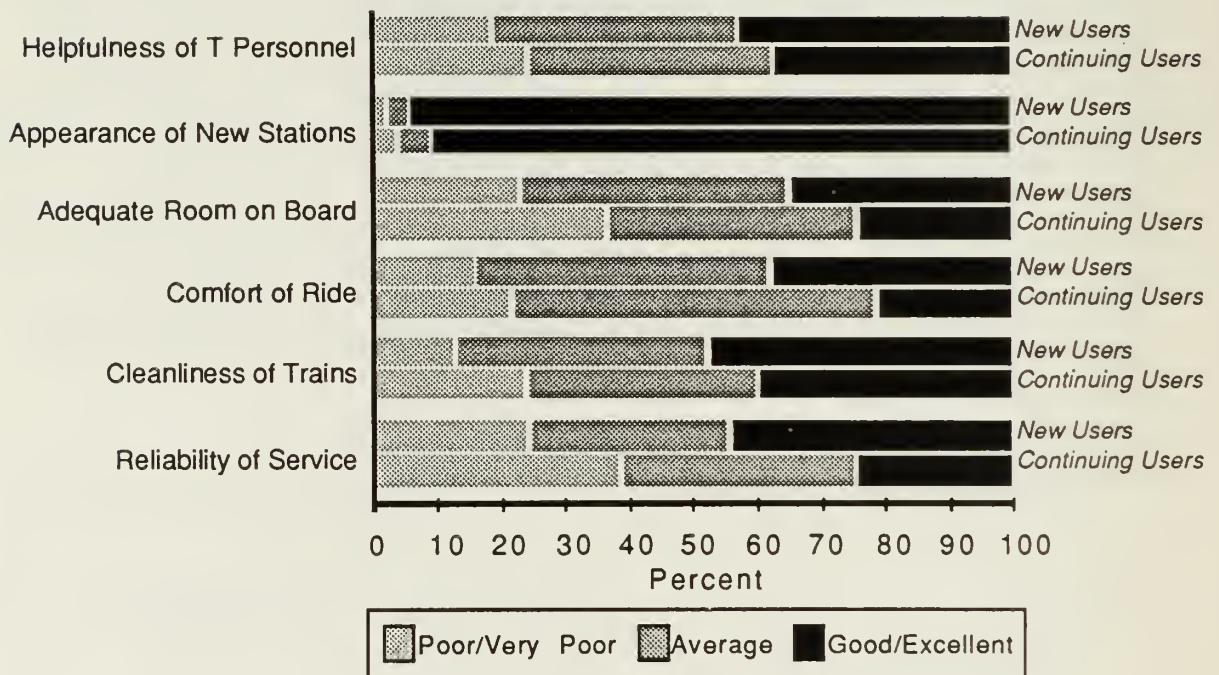
<u>Measure</u>	<u>% Pass. Rating Average or Better</u>	
	<u>South Shore</u>	<u>Alewife Extension</u>
Reliability	37.4%	68.8%
Cleanliness of Trains	64.4%	82.0%
Comfort of Ride	47.3%	80.2%
Appearance of Stations	61.7%	97.7%
Helpfulness of Employees	63.0%	78.6%

There are various possible reasons for the higher ratings of Alewife riders. One possibility is that actual improvements have occurred on the Red Line, and that these improvements are reflected in passenger attitudes. Secondly, there are differences between the two groups that may affect

attitudes. (South Shore riders, in general, are older, less transit dependent, and are more affluent.) Third, it is clear that Alewife extension riders think highly of the new stations; positive feelings about the stations may carry over into other ratings.

There was also a noticeable difference between the ratings of new riders and those of continuing riders. In all cases, new riders rated the extension and the Red Line more favorably than did continuing users (see Figure 4-4). The largest differences were apparent in the areas of reliability and crowding. With respect to the former, 62 percent of continuing riders rated service as average or better, compared to 76 percent of the new riders. Similarly, 64 percent of continuing riders rated crowding conditions as average or better, compared to 71 percent of new riders.

Figure 4-4
Passenger Ratings of Service Quality



The difference in most ratings is probably attributable to various related factors. Ratings of new users reflect the shorter timeframe upon which perceptions are based. Most continuing riders experienced all of the reliability problems of the past few years, whereas new users have only experienced more recent improved conditions. Also, new users rate the Red Line relative to their recent experiences with

other transportation modes which they gave up in favor of the Red Line, and their preference for the Red Line colors their ratings. Alternatively, continuing users have had time to "forget" their experiences with other means of transportation; their judgements are more apt to be based on the tendency of people to seek improvements in what they have and are used to.

Ratings did not significantly differ by boarding station (notwithstanding that most new riders board at the new stations, and most continuing riders board at Harvard) When viewed by station, ratings of service quality indicators usually parallel the ratings for the extension as a whole, with the exception that Porter riders rate service slightly more harshly than others.

Of the 2436 passengers who responded to the passenger survey, 1162, or 48 percent also provided comments. These are summarized in Table 4-5. In general, the comments show that many riders are satisfied with MBTA service, but that more desire an improvement in one or more aspects of service. Commonly-cited areas in need of improvement are: train reliability, room on-board trains, public information, station cleanliness, and escalator reliability.

The likely reason for there being more negative than positive comments is that dissatisfied riders have stronger feelings about service than satisfied riders and, thus, have a greater tendency to offer a comment. For example, 45 percent of the respondents who rated reliability as poor to very poor also added a comment about reliability problems, while less than one percent of the riders rating reliability as good or excellent added a positive comment.

As with the attitudinal ratings discussed above, the comments of continuing riders were more critical than were those of new riders, as shown in Table 4-5.

Table 4-5
Summary of Survey Comments

	Percent of Survey Respondents Making Comment		
	Continuing Users	New Users	Both Groups
<u>Red Line Reliability</u>			
Too many breakdowns/delays	9.6%	7.9%	8.7%
Service is unreliable	4.8%	1.8%	3.2%
General dissatisfaction	3.6%	0.8%	2.1%
Reliability has improved/is good	0.2%	0.1%	0.2%
Other	0.7%	0.8%	0.8%
<u>Level of Service</u>			
Increase frequency of service	2.6%	6.1%	4.4%
Don't turn trains at Davis	0.6%	1.9%	1.3%
Don't turn trains at Park St.	1.9%	0.7%	1.2%
Operate express service	0.7%	0.5%	0.6%
Increase span of service	0.4%	0.4%	0.4%
Operate longer trains	0.1%	0.1%	0.1%
<u>Quality of Train Service</u>			
Trains too crowded/uncomfortable	5.3%	4.2%	4.7%
Provide better security on trains	1.9%	1.8%	1.9%
Ride is too jerky	1.9%	1.7%	1.8%
Enforce No Smoking Policy	1.2%	1.2%	1.2%
Trains too noisy	0.8%	1.1%	1.0%
Complaints about other passengers	1.5%	0.4%	0.9%
Trains too hot or too cold	0.8%	0.5%	0.7%
Seats are uncomfortable	0.4%	0.3%	0.4%
Other - negative	1.1%	0.4%	0.7%
Other - positive	3.7%	0.4%	2.0%
<u>Connecting Bus Service</u>			
Provide more bus service	4.6%	1.7%	3.1%
Provide better bus/rail coord.	0.5%	0.8%	0.6%
Bus Service is good	0.9%	0.2%	0.5%
Improve bus dispatching	0.5%	0.3%	0.4%
Bus Service is poor/unreliable	0.5%	0.3%	0.4%
Operate Route 350 as before	0.0%	0.6%	0.3%
Other	2.0%	1.3%	1.7%
<u>Public Information</u>			
Announce reasons for delays	5.2%	3.3%	4.2%
P.A. System hard to understand	3.8%	2.2%	3.0%
Provide better public info.	1.3%	2.3%	1.8%
Destination signs often wrong	0.7%	0.9%	0.8%

Table 4-5 (cont)
Summary of Survey Comments

	Percent of Survey Respondents Making Comment		
	Continuing Users	New Users	Both Groups
<u>Stations</u>			
Escalators too often don't work	2.8%	2.5%	2.7%
Stations are dirty	1.9%	3.5%	2.6%
Like new stations	0.5%	4.0%	2.4%
New stations are clean	3.2%	0.1%	1.6%
Provide more restrooms/concessions	0.8%	0.3%	0.6%
Improve Alewife pedestrian access	0.6%	0.3%	0.5%
Alewife parking fee too high	0.3%	0.8%	0.5%
Other Negative	2.5%	2.5%	2.5%
Other Positive	0.3%	1.3%	0.8%
<u>MBTA</u>			
Pleased with T service/extension	4.2%	12.5%	8.5%
Employees not helpful/rude	3.5%	2.2%	2.7%
Employees are helpful	1.0%	1.1%	1.0%
Other - positive	0.0%	0.4%	0.2%
Other - negative	1.0%	0.2%	0.6%
<u>Miscellaneous</u>			
Extend Red Line further	0.1%	1.5%	0.8%
Other services	0.2%	0.8%	0.5%
Other - positive	0.3%	0.7%	0.5%
Other - negative	2.0%	2.0%	2.0%
Neutral/Suggestion	1.4%	1.4%	1.4%

In addition to concerns about certain aspects of service, there were also a large number of comments expressing a desire for more service. New riders were more concerned with shorter headways on the Red Line (6.1 percent of new users responding to the survey), while continuing users were more concerned with additional feeder bus service (4.6 percent).

The most frequent comment in the area of public information was that MBTA personnel should announce the reasons for delays (4.2 percent). In addition, three percent of all respondents complained about the P.A. system being garbled or difficult to understand, 1.8 percent expressed a general desire for better public information and slightly less than one percent expressed concern about incorrect destination signs on trains.

Most of the concerns voiced in the Alewife survey are the same or similar to those voiced in previous Red Line surveys conducted in October 1980 and February 1984.¹⁶ The MBTA is currently addressing many of the areas which generate most of the complaints. New and rebuilt rolling stock and track reconstruction along with other ongoing programs should improve reliability, and the operation of six-car trains should alleviate crowding significantly. However, escalator maintenance and provision of adequate public information (especially concerning delays) are areas that still seem to require improvement.

4.1.3 Rapid Transit Boardings Trends

In this section, four basic issues are dealt with: the near-term change in Red Line boardings that occurred when the extension opened, the trend in Harvard Station boardings prior to the extension, the trend in Red Line extension boardings since its opening, and boardings trends at Lechmere and Sullivan Stations, as they relate to the extension.

4.1.3.a Before/After Red Line Boardings

The extension resulted in 12,530 new near-term Red Line boardings at Harvard and the new stations. In November, 1984, there were an estimated 20,500 all-day boardings at Harvard Station. In October 1986, nearly two years after the extension opened, there were 33,500 all-day boardings at Harvard, Porter, Davis and Alewife combined. Taking into account the 470 travellers who shifted to the extension from Central and Kendall, there were then 12,530 new boardings at the four extension stations.

Of these 12,530 new boardings, 9,750 were new Red Line users boarding at the three new stations and the balance were new users who boarded at Harvard and travelled northbound onto the extension. The 12,530 new boardings translate into 19,900 passenger-trips new to the Red Line as a result of the extension.¹⁷

¹⁶ Red Line riders using the Braintree extension were surveyed in October 1980 and on February 29, 1984.

¹⁷ This figure is arrived at by separating local extension travellers from those who travel to or from a point east of Harvard Square. The former were already accounted for in both directions of travel, while the latter were included only once in the boarding counts. (Their return trips from Park, Washington, etc., were not accounted for in the extension boarding counts.) Thus, total new Red Line passenger-trips attributable to the extension was calculated by summing boardings attributable to local travellers and twice the boardings attributable to non-local travellers.

The 1986 extension boardings include an estimated 18,500 at Harvard or 2,000 fewer than before the extension.¹⁸ However, approximately 2,600 of the boardings are in the outbound direction; subtracting them leaves 15,900 inbound boardings or 4,600 fewer than before the extension opened.

According to the April, 1986 passenger survey, approximately 5,250 all-day travellers, given normal service, would have shifted from Harvard to the three new stations. Since this number is 650 greater than the 4,600 decrease at Harvard, it implies that 650 new travellers began boarding at Harvard in the interim. These probably represent a return of travellers who had been diverted from the line due to construction in Harvard Square.

4.1.3.b Previous Trends in Harvard Boardings

Even prior to the opening of the extension, boardings at Harvard Station had been affected by various occurrences such as fare changes and construction. Before construction of the extension, the station had been the most heavily used outside of the Boston Central Business District. Contributing factors included high population density in the station area, numerous heavily-used feeder buses serving the station, and a large number of trip attractions in Harvard Square.

During construction of the extension, ridership was affected by two fare increases and one fare reduction. The Harvard and Harvard/Brattle Stations appear to have suffered unusually large ridership losses as a result. Although the effects of fare changes and construction in Harvard Square, which began in 1979, cannot be separated completely, the largest drop in ridership coincided with the 1980 fare increase.

Before 1980, Harvard had shown above average ridership growth, rising from about 20,500 daily boardings in 1975 to about 23,500 by 1978. After the 1980 fare increase, boardings fell to around 19,000, recovered gradually to 21,000, then fell to 19,000 again after the 1981 fare increase. Ridership reached a low of 17,000 in early 1982, but began recovering after the 1982 fare reduction up to its November 1984 level of 20,500.

¹⁸ Counts between 6:00 a.m. and 8:00 p.m. totalled 17,000. Due to track reconstruction, train service ended at 9:00 p.m. Using proportions from 1978 counts, it is likely that with full service, there would have been another 1,500 boardings after 8:00 p.m. for an estimated all-day total of 18,500.

4.1.3.c Trends in Extension Boardings

In the first two years of operation of the Red Line extension to Alewife, ridership at the three new stations grew at a faster rate than experienced in a similar time span at most stations on extensions opened by the MBTA since 1970. As of October 1986, Porter, Davis and Alewife each averaged about 5,000 daily boardings. This was greater than ridership at Quincy Adams or Braintree, slightly above Wollaston, and not far below North Quincy and Wellington. Conversely, Quincy Center, Oak Grove and Malden each averaged about 20 percent more riders than Alewife extension stations, but they have been in operation much longer.

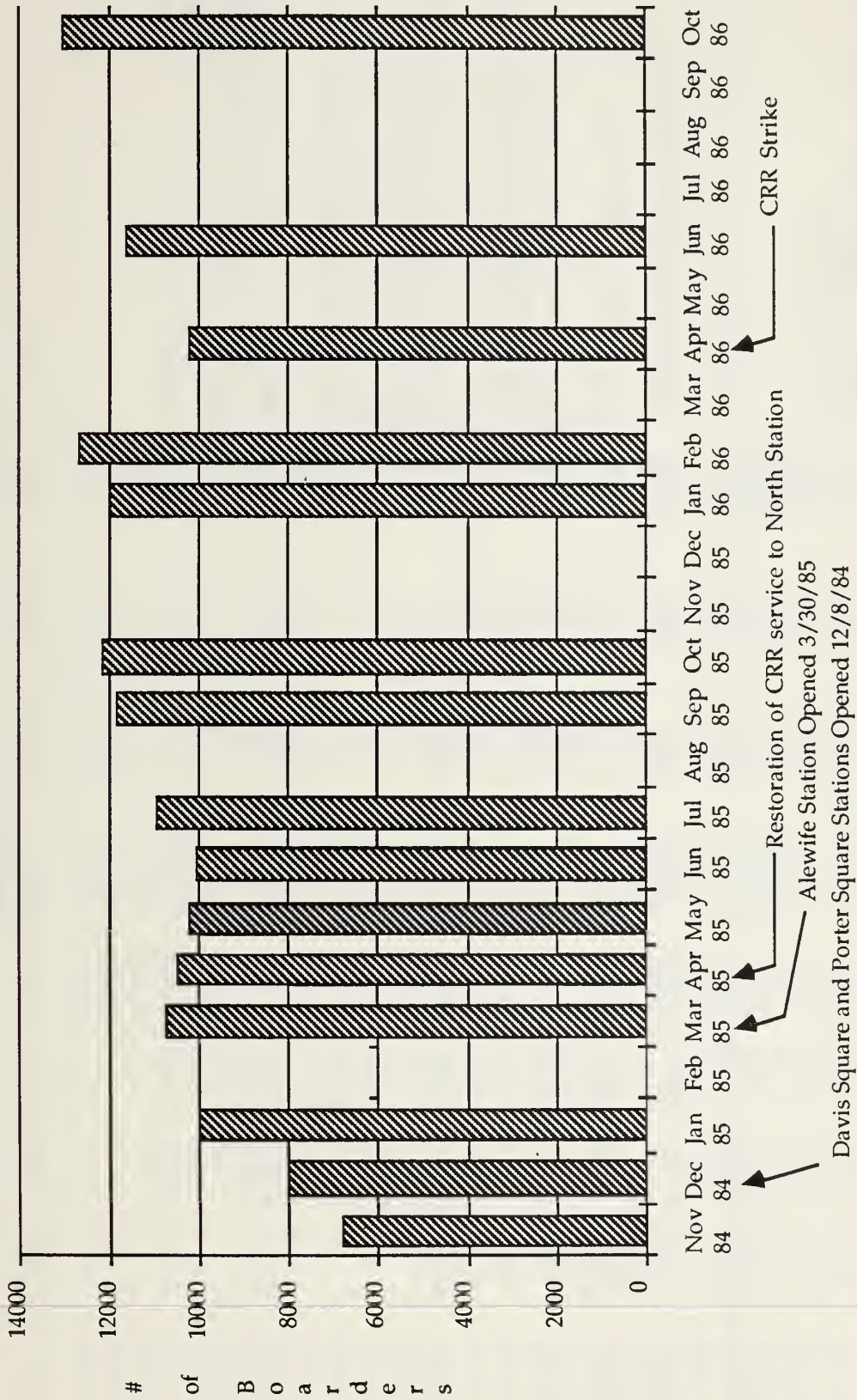
Between the opening of the last new Red Line station - Alewife - and Fall 1986, daily boardings at the three new stations grew steadily from 10,000 to 15,000. However, as expected, boardings at Harvard declined as people shifted to the new stations.

There are many AM peak period boarding counts available and these appear in Table 4-7 and Figure 4-5. Table 4-6 contains all-day boarding counts, of which there are relatively few.

Various occurrences affected extension ridership in the months following opening and these are evident in the AM peak period counts. In September 1985, the Harvard Station bus tunnel reopened, providing a convenient bus to Red Line transfer that had been lacking during construction. Some net Red Line ridership gain occurred, and some shifting from Porter to Harvard occurred as feeder bus patrons opted to ride buses further for the convenience of a sheltered transfer.

In June 1985, four local feeder buses were routed into Alewife Station. Two were re-routed from Harvard, thus the boardings data show increases at Alewife and decreases at Harvard, but overall Red Line extension increases. Express Route 350 was routed into Alewife in September 1985 and caused Red Line extension boardings to register another increase.

Disruptions to commuter rail service impacted rapid transit ridership between 1984 and 1986. From January 1984 to April 1985, north side commuter trains were unable to reach their normal terminal at North Station because of a bridge fire. The Fitchburg Route was temporarily served by shuttle buses to East Cambridge, but when Porter Station opened in December 1984, Fitchburg Route passengers were able to transfer directly to the Red Line there. Once North Station reopened in April, however, about 1,000 inbound



Alewife Before/ After Study

December 1987

RED-LINE STATIONS
HARVARD THROUGH ALEWIFE
6:30-9:30AM - BOARDINGS TREND
FROM NOV 1984 - OCT 1986

CTPS

FIGURE
4-5

Table 4-6
Alewife Before/After Study
Red Line Boardings - All Day Counts

Date	Alewife	Davis	Porter	Harvard	Sub-Total		Sullivan	Total All Stations	Comments
					Red-Line	Lechmere			
Nov-84				20,450	20,450	5,599	6,501	32,550	Estimated from Revenue Information;
Apr-85	1,739	3,625	4,679	18,100	28,142	5,476	5,838	39,456	Expanded from 6:00am-1:45pm counts.
Oct-85	4,762	5,057	5,116	17,400	32,335	4,323	7,699	44,357	Estimated from Revenue Information; Does not include an estimate of riders diverted due to busing between Harvard and Park Street.
Apr-86	5,476	4,907	3,751	17,760	31,894	4,507	7,249	43,650	Estimated from Revenue Information; includes travelers diverted due to CRR* strike, except Porter Station loses normal CRR traffic. Does not include an estimate of riders diverted due to busing between Harvard and Park Street.
Oct-86	5,573	5,232	5,118	17,837	33,760	4,724	6,882	45,366	Estimated from Revenue Information; includes an estimate of riders diverted due to busing between Harvard and Park Street after 8:15pm

Table 4-7

Alewife Before/After Study
Red Line Boarding Counts - 6:30AM-9:30AM

Date	Alewife	Davis	Porter	Harvard	Sub-Total		Lechmere	Sullivan	Stations	Total All	Comments
					Red-Line	Harvard					
11/27/84				6,827	6,827		2,204	5,455	14,486		
12/04/84				6,826	6,826		2,449	5,416	14,691		
12/05/84				6,736	6,736		2,497	na	na		
12/11/84		1,690	2,446	4,893	9,029		1,461	3,694	14,184		Davis & Porter opened 12/8
12/13/84		1,701	3,000	4,912	9,613		1,455	3,878	14,946		
01/07/85		1,263	3,006	4,977	9,246		1,999	3,271	14,516		
01/10/85		1,488	3,678	4,995	10,161		1,854	3,274	15,289		
01/23/85		1,980	3,480	4,979	10,439		na	na	na		
01/30/85		1,624	3,573	5,037	10,234		1,667	na	na		
03/06/85		1,754	3,706	5,180	10,640		1,883	4,117	16,640		
03/14/85		1,950	3,481	5,119	10,550		1,963	3,717	16,230		
03/22/85		1,899	3,266	5,263	10,428		1,946	na	na		
03/25/85		2,087	4,052	5,254	11,393		1,998	na	na		
04/02/85	542	1,976	3,158	4,675	10,351		2,144	5,001	17,496		Alewife opened 3/30
04/10/85	622	1,999	3,615	4,649	10,885		1,995	4,809	17,689		
04/22/85	618	2,148	2,733	4,698	10,197		1,700	4,098	15,995		North Station re-opened 4/20
05/02/85	613	2,073	2,964	4,739	10,389		1,889	4,593	16,871		
05/22/85	738	1,755	3,539	4,049	10,081		1,848	4,944	16,873		
06/19/85	856	2,246	2,864	4,133	10,099		1,600	4,911	16,610		
06/27/85	867	2,365	na	4,401	na		1,711	4,548	na		Feeder Buses rerouted 6/22
07/16/85	1,407	2,210	3,331	4,024	10,972		1,831	4,327	17,130		
09/05/85	1,506	1,929	3,944	4,336	11,715		1,475	4,661	17,851		
09/10/85	1,934	2,850	3,632	4,599	13,015		1,942	5,650	20,607		350 rerouted & Harvard Bus Tun. reopened 9/7
09/20/85	1,618	2,226	2,938	4,075	10,857		1,820	5,782	18,459		
10/03/85	1,703	2,789	3,953	3,722	12,167		1,575	6,342	20,084		
01/22/86	2,228	2,767	3,298	3,744	12,037		1,745	4,796	18,578		
02/21/86	2,017	2,856	3,197	4,646	12,716		1,782	3,886	18,384		School Vacation Week CRR Walkout
03/21/86	3,511	2,863	na	5,685	na		1,712	4,759	na		
04/17/86	3,078	2,489	2,039	2,640	10,246		1,812	3,810	15,868		Includes travellers diverted due to CRR strike
05/20/86	3,127	2,742	2,129	na	na		na	na	na		Estimated From 600am-930am Counts
06/19/86	2,320	2,639	2,187	4,523	11,669		1,626	3,883	17,178		Estimated From 600am-930am Counts
08/15/86	2,319	2,532	1,981	na	na		1,317	3,297	na		Estimated From 600am-930am Counts
10/15/86	3,116	3,331	2,687	3,915	13,049		1,730	3,817	18,596		Estimated From 600am-930am Counts
01/30/87	na	3,358	2,576	4,164	na		1,763	3,577	na		Estimated From 600am-930am Counts
03/25/87	na	na	na	na	na		na	3,715	na		Estimated From 600am-930am Counts

* Commuter Rail Road (CRR)

commuter rail transfer passengers stopped using Porter Station.

The largest impact on rapid transit ridership occurred in April 1986, when approximately 8,000 round trips per day were lost to commuter rail because of a strike. These riders were dispersed among many facilities, so the impact at most individual rapid transit stations was fairly small. Of the three extension stations, only Alewife apparently had significant commuter rail passenger diversion during the strike, with over 850 on the survey day. Although commuter rail ridership figures indicate that most riders returned to that mode after the strike, growth in other traffic at Alewife seems to have made up for this.

Peaking characteristics at the Red Line stations show expected patterns. Counts taken at Harvard in April 1978 and in November 1984 both indicated that about one-third of daily boardings occurred between 6:30 and 9:30 a.m. In contrast, the Ashmont and South Shore branches of the Red Line, both ends of the Orange Line, and the Blue Line experience about half of their daily inbound boardings in the morning peak period. The lower ratio at Harvard is attributable to the role of Harvard Square as a significant trip attractor as well as trip generator.

As of April 1986, the three new extension stations showed peaking characteristics typical of the outer ends of other MBTA rapid transit lines. Including an estimate for expected ridership after 8:00 p.m., the three stations combined had 49 percent of their daily boardings in the three-hour morning peak-period.

The peak factor at Harvard had, by the spring of 1986, dropped from 33 percent to 23 percent. This is not surprising given that morning peak commuter trips to points east of Harvard would have the greatest potential for diversion to the new stations. Evening inbound commuting trips home from Harvard Square, which contribute to the above-average proportion of boardings outside the morning peak, would not be diverted at all. October 1986 counts indicate continuing diversion of riders from Harvard to the new stations, with the rate of shift remaining higher in the morning peak than during the rest of the day.

In the future, ridership on the Red Line extension is likely to continue to grow. New development in downtown Boston and Cambridge, along with limited expansion of highway and parking capacity, has been a major factor in transit ridership growth to date and should continue to be in the foreseeable future. Also, other new rapid transit extensions built by the MBTA in recent years have taken much longer than two years to realize a full, stable level of ridership.

The expansion of the Red Line fleet, which will occur soon with the delivery of new cars and the re-introduction of rebuilt cars, should also play a role in increasing ridership by increasing the capacity of the line and by improving service reliability.

Past experience has shown that new reliable passenger equipment has a strong positive impact on ridership. For example, since delivery of new cars in 1979, Blue Line ridership has grown more than 30 percent, with no extension of the line, and few station improvements. Therefore, deployment of new rolling stock should result in an even stronger Red Line ridership growth trend than is already apparent.

4.1.3.d Lechmere and Sullivan Station Boardings

It was anticipated prior to the building of the Red Line extension that passengers would be diverted to it from Lechmere and Sullivan Stations. According to the passenger survey, such diversions did occur. Approximately 520 daily passengers using Alewife, Davis and Porter Stations diverted from Lechmere Station and 350 diverted from Sullivan. In addition, 120 shifted from Wellington Station.

It is not surprising that the largest diversions would have come from Lechmere Station. It is the terminal for four MBTA bus routes. Of these, one also serves Harvard Station, and two also serve Davis Station. One of the latter also passes within 750 feet of Porter Station. The fourth route is intersected at several points by bus routes running directly to extension stations. Hence, there is a strong potential for diversions of users of these routes from Lechmere to Red Line stations. Users of the 350-car parking lot at Lechmere would also be potential candidates for diversion to Alewife Garage.

Ridership trends at Lechmere do not correspond with reported Red Line diversions due to the influence of other factors. Ridership at the station has fluctuated during the past decade, but the overall trend has been one of decline. Between November 1984 and April 1986, Lechmere showed a net drop of approximately 1,100 riders per day, or more than twice the reported number of diversions. Ridership at Lechmere in November 1984 may have been inflated because of commuter rail passengers who shifted while North Station was closed. Some of the remaining 1984-86 drop can be attributed to the usual fluctuation in Lechmere boardings.

Another recent influence on Lechmere boardings appears to have been operations related. From early 1984 through the end of 1985, peak period service to Lechmere was provided by

shuttle trains running only as far as Government Center. The provision of this service correlates with a ridership decline, and apparently was the cause of some of that decline. Revenue data and passenger counts both indicate a gradual growth in Lechmere boardings since the restoration of peak-period service beyond Government Center.

It is likely that a higher portion of peak than off-peak riders have been diverted from Lechmere to the Red Line. Counts taken by CTPS at Lechmere Station in October 1985 indicated that the proportion of passengers arriving at the station on foot is lowest in the morning peak. Hence, the proportion arriving by bus or auto is highest then. The latter two groups are susceptible to diversion to the Red Line, so it would be expected that a higher proportion of peak than off-peak riders have been diverted. In fact, limited observations do seem to indicate a reduction in the ratio of peak to total boardings at Lechmere.

Sullivan Station has no feeder bus routes that previously served Red Line extension station areas. However, several areas with bus service to Sullivan also have bus service to Davis or Porter Squares. Bus patrons, then, unlike those going to Lechmere, would not simply be able to continue to use their same bus to go to extension stations: they would have to start using a different bus. Thus, potential for shifting of Sullivan-bound feeder bus patrons to the Red Line exists, but not as strongly as for those bound for Lechmere. Additionally, Sullivan has 190 commuter parking spaces in lots operated by the MBTA, and additional capacity in adjoining private lots. Some of the park & riders using these lots would be potential candidates for diversion.

The effect of the Red Line is more clearly seen at Sullivan than at Lechmere Station. October 1986 revenue data show a drop at Sullivan consistent with diversions indicated by the Red Line passenger survey. Sullivan Station has shown an overall trend of moderate ridership growth during the past decade until recently. Prior to the opening of the Red Line extension, about 7,200 passengers per day boarded at Sullivan. Partly because of commuter rail diversions resulting from the North Station and Beverly bridge fires and the 1986 strike, Sullivan did not begin to show a net ridership loss until the latter half of 1986.

4.1.4 Changes in Travel Behavior/Travel Market

4.1.4.a Overview

Current travellers on the Red Line extension can be divided into two groups: continuing users and new users. The latter can be further divided into those who used to make the same trip by different means and those who did not used to

make the trip. These groupings are used in the discussion of changes in travel behavior that follows. The discussion focuses on current users of the three new stations and it concerns only those who boarded between 6:30 a.m. and 6:30 p.m., the period during which passengers were surveyed. (The figures reported, being for a 12-hour period, should not be confused with the all-day boardings figures reported in the previous section.)

For all four Red Line extension stations together, 48 percent of the travellers are continuing users, 22 percent are those who used to make the trip by different means and 30 percent are those who did not previously make the trip. For the three new stations alone, the figures are markedly different. Only 35 percent of these travellers are continuing users; 30 percent used to make the trip by different means and 35 percent did not previously make the trip. (Please refer to Table 4-8.) The difference is due to the large number of Harvard boarders whose travel behavior was unaffected by the extension: the majority of them are continuing users whereas at the other three stations, continuing users are in the minority.

Among boarders of the three new stations who used to make the same trip, either by Red Line or other means, the majority formerly used the MBTA. In addition to the 4840 continuing Red Line users, 1530 were drawn from MBTA buses used as a primary mode, 290 were drawn from commuter rail and 920 were drawn from the Orange and Green Lines. This leaves 1350, or 15 percent of all people who used to make the same trip, who were drawn to the Red Line extension from automobiles, walking and other miscellaneous modes.

It is not clear what portion of the new Red Line travellers who previously made the same trip by other means would have begun using the Red Line if the extension had not been built. (Trends at Harvard Station can be used, to an extent, as "control" trends. However, as noted previously, the Harvard survey data become unstable when disaggregated to the level needed to track specific pairs of mode shifts.) Some natural shifting among travel modes does occur in any market and some would have occurred into and out of the Red Line market. It is likely, though, that mode switching would have been small for the following reasons.

Among those who previously made the same trip by different means, 28 percent now park & ride at the Red Line. Due to the difficulty they would have encountered in parking in congested Harvard, Central, or Kendall Squares, it is not likely that many would have opted to start parking and riding at the Red Line. Furthermore, forty-six percent of this new Red Line market now walks to the Red Line. If they are close enough to walk to Alewife, Davis and Porter Stations, most would not be close enough to Harvard to have started walking

there. Finally, 19 percent of this new Red Line market now uses feeder buses to access the line. Over half of these travellers board at Alewife and Davis and previously used MBTA buses as their primary means of travel. Most of these people are travelling to Harvard Square and used to use routes such as 76, 77, 84 and 96. These people would not logically have started boarding the Red Line at Harvard. Others of these were previously using Route 350 to travel to Haymarket and most would have lived too far out to take another bus to Harvard Square to transfer to the Red Line and those who could have done so would have given up a one- for a two-seat ride and would have faced increased fares.

The only major access mode on which continuing users predominate is the MBTA feeder bus mode where they account for fifty-three percent of the travellers. Alternatively, new users predominate in the park & ride (78%), kiss & ride (61%), and walk (69%) access modes. These findings are consistent with the fact that the extension made automobile and walk access to the line much easier, but that bus access, although it increased according to most measures, did not do so as dramatically. Moreover, increases in the feeder bus market, even with the enhanced Red Line accessibility afforded by the new network, would naturally occur more slowly because buses are generally not perceived to be as desirable as automobiles or walking.

Following, is a discussion of extension users by group.

4.1.4.b Continuing Users

Among continuing Red Line users boarding at Alewife, Davis and Porter Stations between 6:30 a.m. and 6:30 p.m., close to half (44%) have changed their modes of access to the Red Line. Within this market, park & riding doubled, kiss & riding increased three-fold and walking increased by two-and-a-half times. None of this is particularly surprising, given that the extension provided 2200 spaces of additional parking and that the new stations are in less congested areas closer to the homes of many who can now walk or more easily be dropped off at the line.

Increases in the shares of the above access modes came at the expense of feeder buses. The number of continuing Red Line users using buses to access the Red Line is half what it used to be. Most of those lost to the buses now walk to the three new stations. In fact, this shift from bus to walking was the single largest shift in travel behavior among continuing users, representing 60 percent of all whose access mode changed. Other significant access mode-to-mode shifts were from bus to park & ride (14 percent of access mode shifters) and from bus to kiss & ride (10 percent).

Once again, the shifting of continuing users out of feeder buses is not surprising, given that the extension brought the line physically closer to their homes in Somerville and North Cambridge, and that it made automobile access to the line less onerous.

As one would expect, the station previously used by continuing users was, overwhelmingly, Harvard Station, as shown in Table 4-9. Among users of the three new stations, 91 percent previously boarded at Harvard. However, six percent boarded at Central Square Station. The latter are largely residents of North Cambridge who used to take Route 83 to Central Square, but who now walk to Alewife Station, or who walk or continue to take Route 83 to Porter Station. Three percent of the continuing users used to board at Kendall or Charles Stations. The largest group of these are people who used to drive or take Route 350 to Kendall Station and now continue to drive or to take Route 350, but to Alewife instead.

Table 4-9
Continuing Red Line Users
Current and Former Boarding Station

<u>Former Station:</u>	<u>Current Station:</u>				<u>Total</u>
	<u>Alewife</u>	<u>Davis</u>	<u>Porter</u>	<u>Harvard</u>	
Harvard	1,685	1,221	1,483	8,426	12,815
Central	178	21	82	242	523
Kendall	73	21	8	0	103
Other	9	51	5	48	114
Total	1,946	1,315	1,578	8,716	13,555

Continuing users as a group, travel on the Red Line slightly more frequently than they did before the extension. Prior to the extension, 52 percent of them travelled five or more days per week on the line. After the extension opened, that percentage increased to 57 percent, as shown in Table 4-10. This finding coincides with the pronounced shifting from feeder bus to walking for current boarders at Davis and Porter Stations. That is, it is likely that several of these travellers, with an easier access to the line, began travelling more often on it.

Table 4-10
Continuing Red Line Users
Before/After Frequency of Use
(Percentages)

<u>Days Per Week</u>	<u>Before</u>	<u>After</u>
seven	2	3
six	7	8
five	43	46
four	6	4
three	11	9
two	8	7
one	5	6
< one	18	17
Total	100	100

At the other extreme, occasional use held steady overall, but not at individual stations. That is, both before and after the extension, 23 percent of all continuing users reported using the line one or fewer days per week. However, travellers currently boarding at Davis and Porter Stations, consistent with the previous finding, shifted out of the one-or-fewer-days-per week category. Before the extension, 18 percent of continuing users now boarding at these two stations were in this occasional use category. Now only 10 and 15 percent at Davis and Porter, respectively, are in this category. Offsetting this, occasional users among those now boarding at Alewife and Harvard increased by six and four percentage points, and now represent 21 and 30 percent of boarders, respectively.

4.1.4.c New Users Who Previously Made The Trip by Other Means

Thirty percent, or 4090 individuals currently boarding at the three new Red Line extension stations between 6:30 a.m. and 6:30 p.m. previously made the same trip, but by non-Red Line means. They number only 750 fewer than the continuing Red Line users.

The predominant access modes in this market are walking (46%), park & ride (28%), and feeder bus (19%). The distribution of these travellers across access modes differs from that of continuing users in two significant ways: a greater share of them access the Red Line by parking & riding and a smaller share use MBTA feeder buses.

Once again, this finding is consistent with the idea that the extension provided new parking capacity that was attractive to those not using the Red Line, but that the reoriented bus network did not provide as immediately an

attractive a new travel option for these people. Seventy-six percent of those who park & ride to the extension were already in automobiles, and a slightly higher 80 percent of those using feeder buses were already using buses - often the same routes that were re-routed into the new extension. More to the point, more people in this market were already in automobiles than on buses (880 versus 615), so it is reasonable that more of them access the Red Line by parking & riding.

The shares of new users who access the Red Line by walking and by kiss & ride are about the same as those of continuing users. This is because the extension made both of these options more attractive for everyone - continuing and new users alike.

The major previous travel modes for travellers in this market are line-haul bus (37% of them), automobile - drive-all-the-way (28%), and the Orange/Green Lines (22%). Among the latter, 78 percent accessed the rapid transit lines by MBTA feeder bus.

Viewed from the perspective of new versus continuing transit riders, an interesting finding results. Precisely two-thirds of this market or 2740 individuals previously used transit services for all or part of their trips; one-third or 1350 shifted from automobile, walking and miscellaneous modes. This finding is perfectly consistent with the two-thirds/one-third rule-of-thumb commonly employed in transit route-level demand estimation.

The largest individual mode-to-Red Line access mode shift was from line-haul bus to walking to the Red Line. Twenty percent of this market made such a shift. Other large shifts were from drive-all-the-way to park & ride (14%), from Orange/Green Line via feeder bus to walk (12%), from line-haul bus to feeder bus (11%), and from drive-all-the-way to walk (9%).

Stated differently, many travellers who were in automobiles continued to use them for the start of their trips, several on buses stayed on them and became dual transit mode users, and many people left automobiles and buses behind and began walking instead.

Automobile-involved trips, those either made wholly or partially by automobile, decreased among travellers in this market. Previously, approximately 1550 of these people made automobile-involved trips and currently 1360 do so. This translates into 190 or 12 percent fewer individuals in this market making automobile-involved trips. Stated differently, 580 people shifted away from automobile-involved trips, while 390 people shifted to such trips.

The majority of those who previously made an automobile-involved trip still do. Forty-four percent of those who used to drive-all-the-way shifted to walking or feeder bus in order to get to the Red Line, leaving 56 percent who park & ride or kiss & ride. Of those who previously drove to, or were dropped off at, Orange or Green Line stations, 39 percent shifted mainly to walking to the Red Line, leaving 61 percent who still park & ride or kiss & ride, but at the Red Line.

The majority of those who shifted to an automobile-involved trip in order to use the Red Line shifted out of line-haul buses. These 260 individuals constitute 17 percent of all who previously used line-haul buses. Smaller groups of people who shifted to automobile-involved trips previously accessed commuter rail stations by non-automobile means or Orange and Green Line stations by feeder bus.

4.1.4.d New Red Line Users Who Did Not Previously Make Trip

Thirty-five percent or 4834 of the boarders at the three new Red Line extension stations between 6:30 a.m. and 6:30 p.m. did not previously make the same trip. This group of travellers is exactly the same size as the continuing users and larger by 750 than the market of new users who previously made the trip by non-Red Line means.

Aside from the fact that they did not previously make the same trip, not much is known about the previous trip-making characteristics of these people. Most of them began making their trips for reasons other than that the Red Line extension was built. Many changed a home or work location, so that they were previously making a different trip. Others moved into the Boston area from elsewhere. Still others entered school or the workforce and, thus, began making trips anew. However, the fact that the Red Line was extended caused many who would have accomplished their new trips by other means to do so by Red Line.

The distribution of these travellers across access modes is similar to that of those who were previously making the same trip (either by Red Line or other means), except that relatively fewer use feeder buses and relatively more walk. In fact, these people make up the largest share of all who walk to the Red Line. This finding is sensible given that the line was extended into very densely settled and transient areas. As a result, Davis and Porter Stations are very close to many people who would be making trips anew. The closer one lives to the line, the more likely one is to choose it over other options for one's new tripmaking, and the closer

one lives to the line, the more likely one will be to walk to it.

Indeed, the data show that new trip makers as a portion of all those who are new to the Red Line is highest, at 68 percent, at Porter Station. Harvard Station, at 65 percent, shows the second highest such portion. Davis, at 52 percent, is next, followed by Alewife at 45 percent. In absolute terms, the greatest number of new tripmakers among the three new stations board at Davis Station (1820), followed by Porter (1639) and Alewife (1373).

4.2 FEEDER BUS SUB-MARKET CHARACTERISTICS

Most patrons of the feeder buses are also part of the larger rapid transit market and have, therefore, been discussed as part of this larger market. However, there are some aspects of this sub-market that merit separate treatment, as follows:

4.2.1 Changes in Feeder Bus Boardings

The Red Line extension resulted in an overall increase in transit ridership on the services considered of 26.4 percent. Red Line ridership between Alewife and Harvard in the Spring of 1986 was 19,900 trips per weekday, however, some of this increase was offset by a decrease in bus ridership of 7,340 trips per day. As would be expected, most of the ridership decrease occurred on routes serving the same areas now served by the Red Line extension, as ex-bus riders can now walk directly to the Red Line at Alewife, Davis and Porter. By route, ridership on each of the fifteen bus routes before and after the opening of the extension is as shown in Figure 4-6 and Table 4-11.

Figure 4-6
Weekday Bus Ridership Before/After

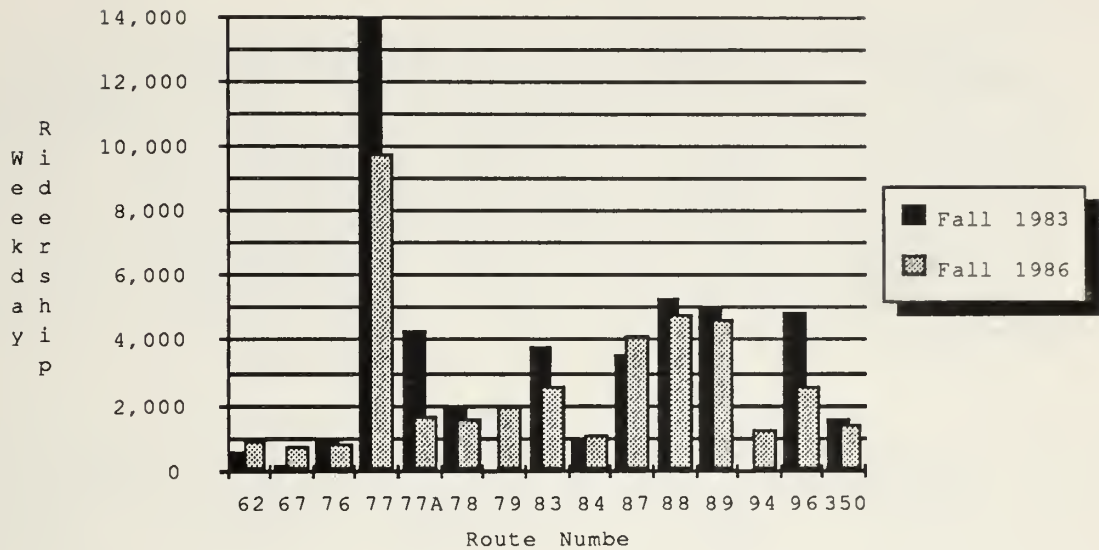


Table 4-11
Weekday Ridership Before/After

Route		Fall 1983 Ridership	Fall 1986 Ridership	Change
62	Bedford - Alewife	590	950	62.5%
67	Turkey Hill - Alewife	190	730	276.2%
76	Hanscom - Alewife	950	850	-9.8%
77	Arl. Hts. - Harvard	13,990	9,790	-30.0%
77A	No. Cambridge - Harvard	4,360	1,660	-62.0%
78	Park Circle - Harvard	2,040	1,570	-23.0%
79	Arl. Hts. - Alewife	0	2,010	NA
83	Rindge Ave. - Central	3,820	2,600	-32.0%
84	Arlmont Loop - Alewife	1,020	1,050	3.0%
87	Clarendon Hill - Lechmere	3,580	4,180	16.6%
88	Clarendon Hill - Lechmere	5,360	4,800	-10.4%
89	Clarendon Hill - Sullivan	5,070	4,630	-8.7%
94	Medford Square - Davis	0	1,270	NA
96	Medford Square - Harvard	4,950	2,620	-47.1%
350	Burlington - Alewife	1,590	1,460	-8.2%
TOTAL BUS		47,510	40,170	-15.5%
RED LINE INCREASE		0	19,900	NA
COMBINED TOTAL		47,510	60,070	26.4%

Appendix F contains a route-by-route description of changes in bus boardings.

As a result of the shift by many riders from buses to walking to, driving to or being dropped off at the Red Line, the total number of transfers from all buses to and from the Red Line declined by 2,200 transfers per day from 12,680 to 10,430. (See Figure 4-7 and Table 4-12.) As with ridership declines, the greatest decreases in transfers were on routes whose service areas are now also served by the Red Line extension (Routes 77, 77A and 83). A large decline also occurred on Route 96, but most of this represented a shift of patrons to Route 94.

Figure 4-7
Weekday Transfers Between Buses and Red Line
(Both Directions, Alewife, Davis, Porter and Harvard
Stations)

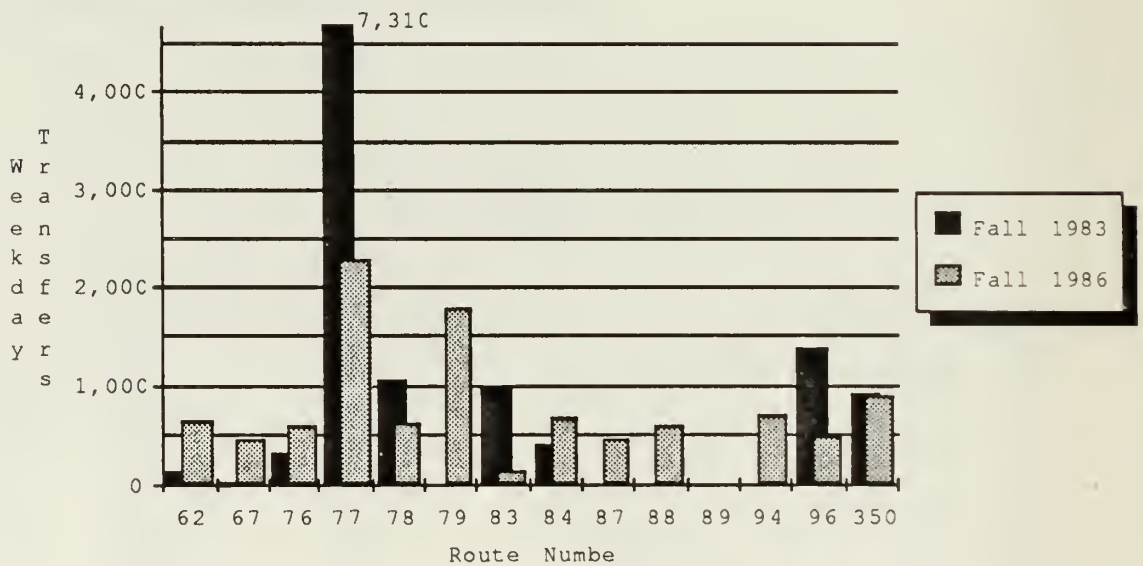


Table 4-12
Weekday Bus-Red Line Transfers
(Both Directions)

	<u>Transfer Location</u>	<u># Transfers</u>	<u>% Change</u>
Route 62			
Before	Harvard(via Rt 77)	150	
After	Alewife	650	333.3%
Route 67			
Before	Harvard via Rt 77	40	
After	Alewife	470	1075.0%
Route 76			
Before	Harvard	340	
After	Alewife	610	79.4%
Route 77/77A			
Before	Harvard	7310	
After	Porter, Harvard	2290	-68.7%
Route 78			
Before	Harvard	1080	
After	Porter, Harvard	620	-42.6%
Route 79			
Before	None	0	
After	Alewife	1810	NA
Route 83			
Before	Central	1000	
After	Porter, Central	140	-86.0%
Route 84			
Before	Harvard	430	
After	Alewife	670	55.8%
Route 87			
Before	None	0	
After	Davis	470	NA
Route 88			
Before	None	0	
After	Davis	610	NA
Route 89			
Before	None	0	
After	None	0	NA
Route 94			
Before	None	0	
After	Davis	720	NA
Route 96/96A			
Before	Harvard	1,400	
After	Davis, Porter, Harvard	480	-65.7%
Route 350			
Before	Kendall, Haymarket	930	
After	Alewife	890	-4.3%
TOTALS			
Before	All Red Line	12,680	
After	All Red Line	10,430	-17.7%

In general, bus routes whose patrons have always been largely composed of Red Line transferees experienced an increase in transfers to and from the Red Line. On Routes 62, 67, 76, 78, and 84, such transfers increased from a total of 2,040 to 3,020 per weekday. However, at the same time, local or non-Red Line trips decreased by 610 from 2,747 per day to 2,137 per day, implying that many of the new Red Line transfer trips are made by persons who previously accomplished their trips using buses alone.

4.2.2 Impact on MBTA Bus Service Performance

With the Red Line extension and additional bus service, additional passenger trips are being carried, but the additional trips are being carried at a higher cost. As a result, the overall productivity of the bus system has declined somewhat (see Table F-1 in Appendix F). In total, some savings have been realized by the utilization of 12 fewer buses (73 now versus 85 before the extension), but most of these savings have been offset by longer operation of the remaining 73 buses. This, coupled with lower bus ridership, resulted in 16 percent fewer passengers carried per vehicle revenue hour (59.7 versus 50.3) notwithstanding that the number of passengers carried per vehicle assigned to the fifteen routes remained fairly stable. For perspective, in 1984, the MBTA bus system averaged 63.8 passengers per revenue hour.

Higher deficit figures, reported previously, are implied by the increase in the net cost per passenger carried (from 41 cents to 55 cents), and by the decline in overall farebox return (from 48 percent to 40 percent).

4.3 PARK & RIDE SUB-MARKET CHARACTERISTICS

As in the preceding section on feeder bus users, those who access the Red Line by park & ride have already been discussed as a part of the larger market of Red Line users. However, in this section, three issues specific to this sub-market are presented. Trends in the use of Alewife Garage, the one large park & ride facility provided by the extension, are presented first. Then the market area of Alewife park & riders is compared to those of Lechmere and Sullivan Stations.

4.3.1 Alewife Garage - Trends in Usage

The chief feature of the trend in the use of Alewife Garage is that it has steadily increased, notwithstanding some seasonal variation, since the garage opened in late

March 1985 (See Figure 4-8). Average weekday use increased by 60 vehicles per month between then and April 1987, the last month for which data are available. The garage started out with 400 to 500 vehicles per average weekday just after opening, and as of April 1987, was up to over 1,700 per average weekday. The highest single day usage occurred in October 1986 when 1,800 vehicles were recorded.

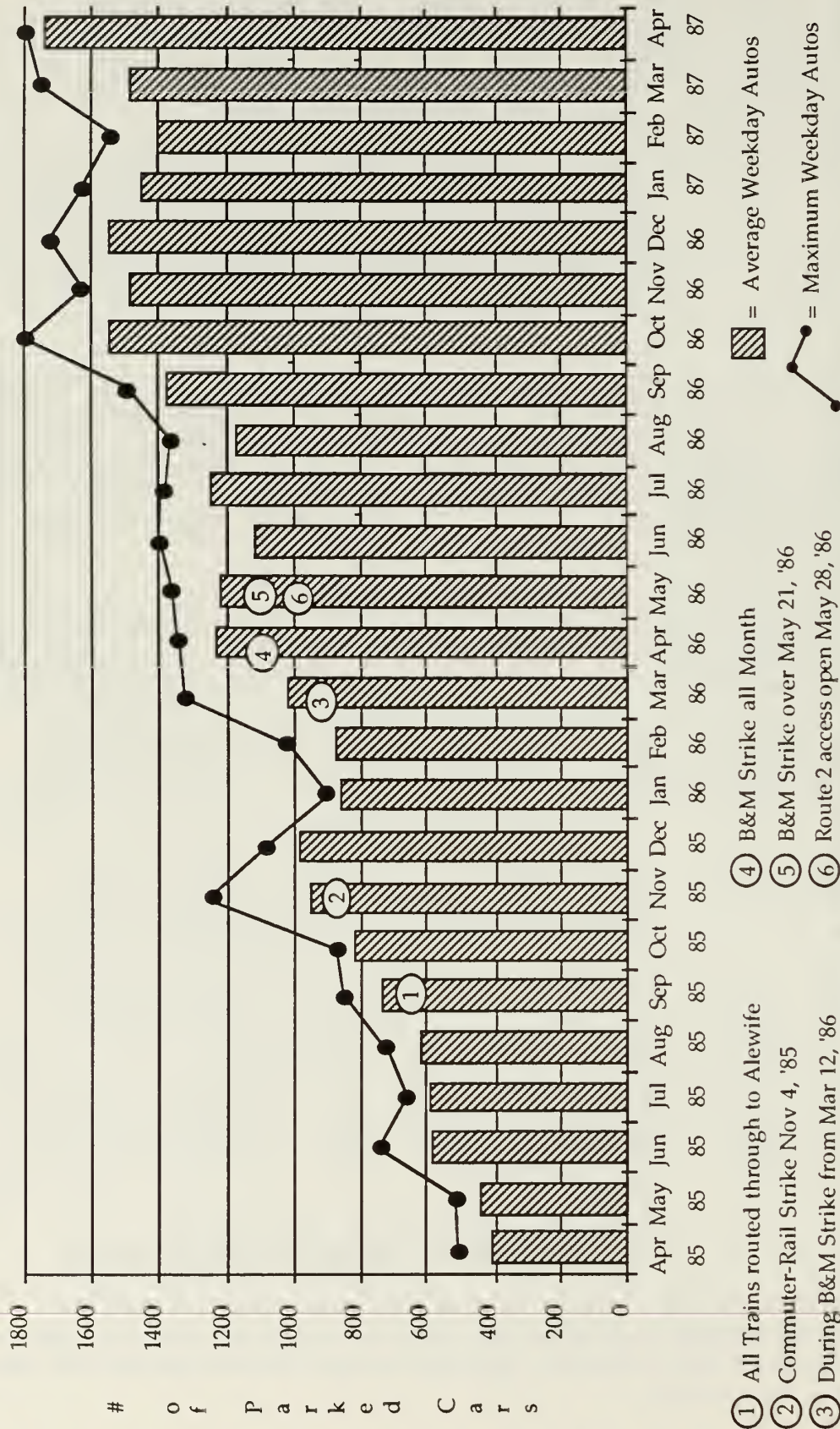
The daily turnover rate at the garage is not known, but if it is similar to other MBTA commuter parking facilities, a factor of 1.05 would be appropriate. Applying this to the 1,744 average weekday vehicles using the garage in April 1987 implies that roughly 1,660 vehicles were parked at one time. This is equal to three-quarters of the 2,200 capacity of the structure.

The influence of various factors is evident in the trend data. For about six months after Alewife Station opened, most, but not all, Red Line trains terminated there. Then, in September 1985, all trains were routed to Alewife and the increased patronage of this action is reflected in the parking counts for that month. (Some part of the increase was seasonal also.)

The commuter rail strike in the Spring of 1986 clearly affected garage usage. Approximately 350 cars using the garage in late March, April, and early May were attributable to such diverted travellers. After the strike was resolved, most of these people returned to commuter rail, but a November 1986 follow-up survey of garage users found that about 40 cars belonged to commuter rail divertees who never returned to that mode.

Another factor influencing garage usage was the completion of the ramps between the garage and the Route 2/Alewife Brook Parkway intersection. The ramp from Route 2 to the garage was completed in May 1986, but since the commuter rail strike was on for most of that month, increased usage then is not apparent. However, between February and June, before and after the ramp completion and before and after the strike, garage usage increased by 231 cars or by 26 percent. Netting out the 40 or so cars belonging to permanently diverted commuter rail travellers still leaves an increase of 191 cars, most of which were presumably induced into the garage, at least in part, because of the new ramp.

In the Fall of 1986, the ramp that allows travel from the garage back into the Route 2/Alewife Brook Parkway intersection was completed and the September and October garage counts once again show a noticeable increase over the previous few months. Some of the increase was no doubt seasonal in nature and some was due to regular growth, but between August and October, garage usage increased by 374 or by nearly one-third.



Alewife Before/After Study

December 1987

ALEWIFE GARAGE USAGE
APRIL 1985 - APRIL 1987

CTPS

FIGURE

4-8

Based on the trend in garage usage, which is nearly linear in nature, there is every reason to believe that parking there will continue to increase steadily in the near future. This is despite a \$3.00 per day parking fee which is high relative to other MBTA parking facilities.

4.3.2 Shifts From Lechmere and Sullivan Commuter Parking Lots

The license plate numbers that were recorded at Lechmere, Sullivan and Alewife Stations indicated that only four vehicles from each of the former switched to Alewife. This is inconsistent with the results of the Red Line passenger survey: the latter showed a higher diversion, somewhere in the range of 10 from Lechmere and 50 from Sullivan. The major reason for this inconsistency is that the boarding survey was done over a 12-hour period, but the plate numbers were taken over a 3-hour period in the morning. Thus, the former would pick up more divertees than the latter. Another possible contributing factor to the discrepancy is that some of the diverted travellers used a different automobile at Alewife than they did at their previous station. Also, all that is known from the passenger survey is whether travellers who were diverted from Lechmere and Sullivan accessed those stations by auto. Some who now park at Alewife may previously have been dropped off at the other stations and thus, their license plates would not have been recorded at their previous boarding stations.

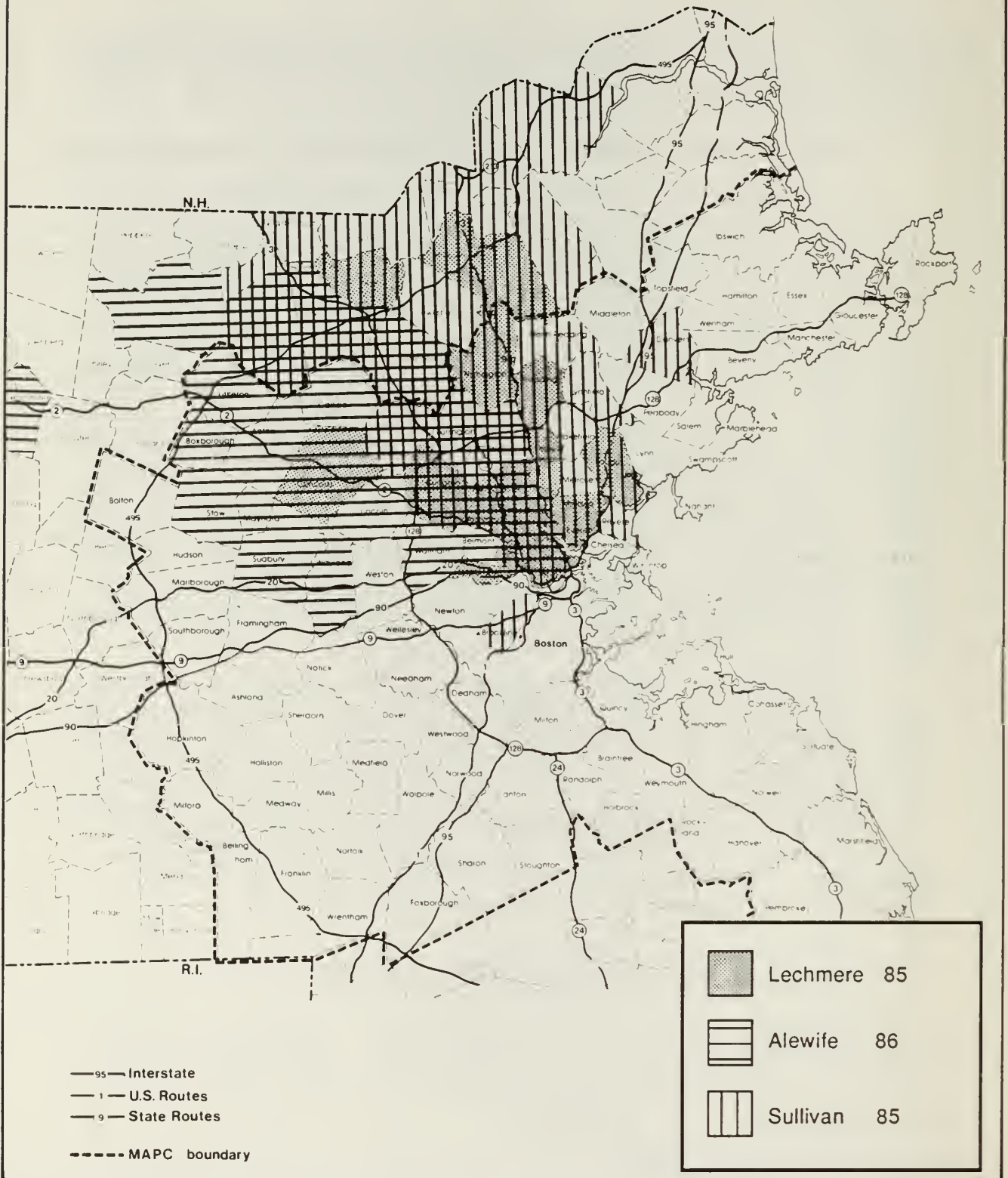
As Figure 4-9 shows, there is some overlap in the park & ride market areas of the three stations and some diversions would be expected, particularly from Sullivan. The latter's market area follows Route 93 to the north, while that for Alewife follows Route 2 to the northwest. The two overlap in the vicinity of Route 3 and towns such as Burlington, Woburn and Winchester are within both. Lechmere's park & ride market area, although much more compact than those of the other two, also overlaps the Alewife market area in such places as Arlington, Cambridge and Somerville.

4.4 CHANGES IN AUTOMOBILE VMT/VEHICLE-TRIPS

It was originally projected that the Red Line extension would have an impact on traffic volumes. Specifically, it was felt that overall vehicle-miles-of-travel (VMT) in the corridor, as well as traffic into Boston and Cambridge would be affected.

4.4.1 Region-wide VMT

It appears that the extension did, indeed, slow the growth of region-wide VMT due to the auto portion of some



December 1987

Cities/Towns of Origin of Parkers at
Alewife, Lechmere and Sullivan Stations

CTPS
FIGURE
4-9

people's trips becoming shorter and to other people foregoing their autos altogether as they switched modes.

The change in VMT was calculated both for continuing and new trip-makers. Within each market, VMT changes for various groups of park & riders and for those who previously drove all the way to their destinations were calculated. However, such changes for kiss & riders were not calculated because the behavior of the person doing the dropping off is not known. That is, it is not known whether the person returns home after the drop off or continues on to another destination. The marginal VMT created in the latter case is probably less than that created in the former, but the information to calculate this does not exist.

Another unknown factor is the trip behavior of those who left the Red Line in the intervening period. Some are making the same trip by other means; others are not making the same trip. Thus, the net change in VMT in the corridor due to travellers shifting to and from the Red Line is unknown. The following pertains to the shifts that are known.

In order to estimate the net VMT "prevented" among new trip-makers, it was necessary to assume that, in the absence of the extension, they would have distributed themselves across modes in the same proportions that the continuing trip-makers, including continuing Red Line users and new Red Line users alike, would have. Furthermore, it was necessary to assume that the auto portion of the trips made by these new trip-makers would have been the same length as those of the continuing trip-makers.

Table 4-13 shows shifts in travel behavior for auto-involved continuing and new trip-makers who boarded at Alewife, Davis and Porter Stations between 6:30 a.m. and 6:30 p.m. in the Spring of 1986. Daily VMT was reduced by 5,700 in the inbound direction or 11,400 in both directions (not including kiss & riders). This represents a 23 percent reduction from the 23,362 inbound VMT that would have been attributable to these travellers in the absence of the extension. This reduction occurred largely because of a reduction in drive-all-the-way auto trips averaging 11.1 miles one-way. Many of these and other travellers attracted to the Red Line now park & ride, but the auto portion of such trips averages only 9.4 miles one-way. In addition, even though there was a net increase in the number of continuing Red Line users who park & ride, the average auto trip length for those in this group decreased from nine to 5.7 miles.

In terms of auto trips, 1,064 drive-all-the-way trips among continuing trip-makers, and 580 among new trip-makers were foregone. However, 921 more auto trips in the first group, and 388 in the second, are now used in parking &

TABLE 4-13
ALEWIFE BEFORE/AFTER STUDY
CHANGES IN AUTOMOBILE VMT
ALEWIFE, DAVIS & PORTER

CONTINUING TRIP-MAKERS:

	<i>Before Red Line Opened</i>	<i>After Red Line Opened</i>	<i>Net Change</i>
CHANGES IN DRIVE ALL THE WAY:			
New Users Who Previously Made Trip			
People	1,149	0	-1,149
Vehicles @ 1.08 people/vehicle	1,064	0	-1,064
Vehicle Miles Traveled	11,804	0	-11,804

CHANGES IN PARK&RIDE:

Continuing Red Line Users			
<i>Park & Ride at Red Line</i>	296	577	281
New Users Who Previously Made Trip			
<i>Park&Ride at Red Line</i>	0	1,164	1,164
<i>Parked &Rode at Orng/Grn Line</i>	149	0	-149
<i>Parked&Rode at Comm Rail Station</i>	191	0	-191
<i>Subtotal</i>	340	1,164	824
Total Park&Ride			
People	636	1,741	1,105
vehicles @ 1.2 people/vehicle	530	1,451	921
Vehicle Miles Traveled	3,305	11,873	8,568

CHANGES IN KISS&RIDE:

Continuing Red Line Users			
	91	296	205
New Users Who Previously Made Trip			
<i>Kiss&Ride at Red Line</i>	0	191	191
<i>Kissed &Rode at Orng/Grn Line</i>	46	0	-46
<i>Kissed&Rode at Comm Rail Station</i>	9	0	-9
<i>Kissed&Rode Elsewhere</i>	25	0	-25
<i>Subtotal</i>	80	191	111
Total Kiss&Ride			
People	171	487	316
Vehicle trips @ 1 person/vehicle	171	487	316

TABLE 4-13 (Continued)
ALEWIFE BEFORE/AFTER STUDY
CHANGES IN AUTOMOBILE VMT
ALEWIFE, DAVIS & PORTER

NEW TRIP-MAKERS:

	<i>If Red Line Had Not Opened</i>	<i>After Red Line Opened</i>	<i>Net Change</i>
CHANGES IN DRIVE ALL THE WAY:			
Would Have Driven All The Way			
People	628	0	-628
Vehicles @ 1.08 people/vehicle	581	0	-581
Vehicle Miles Traveled	6,455	0	-6,455

CHANGES IN PARK&RIDE:

<i>Park & Ride at Red Line</i>	160	810	650
<i>Parked & Rode at Orng/Grn Line</i>	81	0	-81
<i>Parked&Rode at Comm Rail Station</i>	103	0	-103
Total Park & Ride			
People	344	810	466
vehicles @ 1.2 people/vehicle	287	675	388
Vehicle Miles Traveled	1,798	5,772	3,974

Total Known Vehicle Miles Traveled -	23,362	17,645	-5,717
Continuing and New Trip-makers			
(one-way, 6:30 a.m. - 6:30 p.m.)			

riding than would have been without the extension. Combining the reductions in use of autos for driving all the way, with the net increase in use of autos for park & ride, results in a net reduction of 336 auto trips used in trip-making among continuing and new trip-makers (not including kiss & ride trips).

Among continuing trip-makers, there was a net increase of 316 kiss & ride trips. Use of this access-mode actually decreased among continuing Red Line users, but it increased to a greater extent among continuing trip-makers who previously used other modes. As stated previously, the effect that this net increase had on VMT is unclear. If the person dropped off previously took a bus, which many did, and if the driver of the car doing the dropping off returned home afterwards, there would have been an increase in VMT in the accomplishment of the trip. Alternatively, if the driver of the same car continued on to another destination, such as his or her workplace, the increase in VMT could have been minor, if the driver went out of his way to drop his companion off, or there could have been no increase, if the driver was passing the station anyway. For the 84 new kiss & riders who previously drove all the way, VMT associated with accomplishing their trips probably decreased, but this is, once again, not known for sure.

4.4.2 Harvard Square

It was hoped that a benefit of building the Red Line extension would be a reduction in traffic into Harvard Square from the north. Travellers, it was hoped, would be intercepted at the three new stations.

It appears that the extension did moderately slow the net growth of traffic into Harvard Square. This finding is based on the April 1986 passenger survey and traffic counts performed by the MDPW. The latter were taken at two locations through which it was felt that the bulk of traffic from the north would pass: Garden Street between Brattle Street and Appian Way and Mass. Avenue between Mellen and Wendell Streets. These locations were counted in December 1984, before the extension opened, in March 1985 after Porter and Davis opened, but before Alewife opened, and in November 1985 and October 1986 after all stations were open.

Because not all of the machine counts appear to be accurate and because of other influences on traffic, the counts alone do not present a clear indication of the influence of the Red Line on traffic. Combining the survey with the counts does, however, provide a clearer picture. According to the survey, 256 continuing Red Line users no longer park & ride or kiss & ride at Harvard Square between 6:30 a.m. and 6:30 p.m. This translates into 226 automobiles

that no longer travel into Harvard Square, using an auto occupancy of 1.20 for park & riders and assuming that one kiss & rider is dropped off from each car. It further assumes that the drivers of the kiss & ride cars no longer drive through the Square.

Among continuing trip-makers who used to drive-all-the-way to their destinations, 207 used to drive to Harvard Square but now board at one of the new stations. Using an auto occupancy rate of 1.08, this translates into 192 additional autos that are no longer driven into Harvard Square. Among all continuing trip-makers, then, 418 autos are no longer being driven into the Square.

Assuming again that new trip-makers would have distributed themselves across modes and destinations in the same proportions as continuing trip-makers in the absence of the extension, it is estimated that 120 autos were "prevented" from being used for park & riding and kiss & riding at Harvard Square by travellers in this market. In addition, 105 autos were "prevented" from being driven to Harvard Square as an ultimate destination, bringing the total probable diversion of Harvard Square-bound autos in this market to 225. The total, then, of all autos actually and probably diverted from Harvard Square between 6:30 a.m. and 6:30 p.m. as of Spring 1986 is 643.

Consistent data for the first two traffic counts for both count locations is unavailable. Thus, the foregone auto trips calculated from the survey cannot be compared to traffic volumes before the extension opened. However, these trips can be compared to "after" traffic volumes in November 1985. If it is assumed that half the foregone auto trips occurred in the three-hour morning peak period, consistent with boarding patterns, and that all foregone trips would have traversed the two counted arterials proportionate to the volumes on them, then each of the two arterials carried roughly 5.2 percent less traffic during the AM peak period than it would have without the extension.

The before and after counts themselves do show that net volumes declined, but only in some cases, as shown in Table 4-14. Between December 1984 and November 1985, southbound volumes on Mass. Ave. increased by two percent all-day and by five percent during the morning peak period. It is not clear that these percentages are significant, but if they are, they show that the secular growth in traffic more than offset decreases attributable to diverted travellers.

Northbound traffic on Mass. Ave. does show a before/after decrease. All-day volumes actually increased by five percent between December 1984 and March 1985, but decreased by six percent in November 1985, after Alewife was open. Peak

TABLE 4-14
ALEWIFE BEFORE/AFTER STUDY
TRAFFIC COUNTS: HARVARD SQUARE VICINITY

Massachusetts Avenue Between Mellen & Wendell Streets:

Southbound	Before Alewife Station Opened			After Alewife Station Opened			
	Dec. 1984	Mar. 1985	% change	Nov. 1985	% change	Oct. 1986	% change
7:00-10:00 am	2,747	na	na	2,893	5%	3,038	5%
8:00-9:00 am	1,137	na	na	1,233	8%	1,311	6%
4:00-7:00 pm	2,129	na	na	2,001	-6%	2,468	23%
5:00-6:00 pm	704	na	na	729	4%	856	17%
All Day	11,937	na	na	12,149	2%	13,640	12%

<i>Northbound</i>	Dec. 1984	Mar. 1985	% change	Nov. 1985	% change	Oct. 1986	% change
7:00-10:00 am	1,709	1,873	10%	1,851	-1%	2,021	9%
8:00-9:00 am	643	681	6%	630	-7%	771	22%
4:00-7:00 pm	3,212	3,495	9%	3,103	-11%	3,827	23%
5:00-6:00 pm	1,208	1,318	9%	1,100	-17%	1,431	30%
All Day	13,414	14,059	5%	13,159	-6%	15,496	18%

TABLE 4-14 (Continued)
ALEWIFE BEFORE/AFTER
TRAFFIC COUNTS: HARVARD SQUARE VICINITY

Garden Street Between Brattle & Appian Way:

Southbound	Before Alewife Station Opened		After Alewife Station Opened	
	Dec. 1984	Mar. 1985 % change	Nov. 1985 % change	Oct. 1986 % change
7:00-10:00 am	na	na na	3,262 na	3,298 1%
8:00-9:00 am	na	1040* na	1,321 27%	1,338 1%
4:00-7:00 pm	na	na na	3,221 na	3,259 1%
5:00-6:00 pm	na	890* na	1,126 27%	1,203 7%
All Day	na	12112* na	14,999 24%	14,992 0%

Northbound	Before Alewife Station Opened		After Alewife Station Opened	
	Dec. 1984	Mar. 1985 % change	Nov. 1985 % change	Oct. 1986 % change
7:00-10:00 am	na	na na	1,525 na	1,612 6%
8:00-9:00 am	na	653 na	547 -16%	616 13%
4:00-7:00 pm	na	na na	2,268 na	2,580 14%
5:00-6:00 pm	na	977 na	839 -14%	993 18%
All Day	na	10,485 na	10,119 -3%	10,291 2%

* These counts appear unusually low. Some unknown factor may have affected traffic during the counting period or the machine may not have been functioning correctly.

direction, afternoon peak period traffic decreased by 17 percent in the same period.

According to traffic counts, the pattern of traffic volume change on Garden Street was similar to that of Mass. Ave. That is, between the March 1985 count, the only "before" count available for the location, and November 1985, southbound traffic increased, but northbound traffic particularly in the peak hours, decreased. The decreases, however, are much larger than those indicated by the survey; clearly, unknown factors affected the fluctuations in volumes.

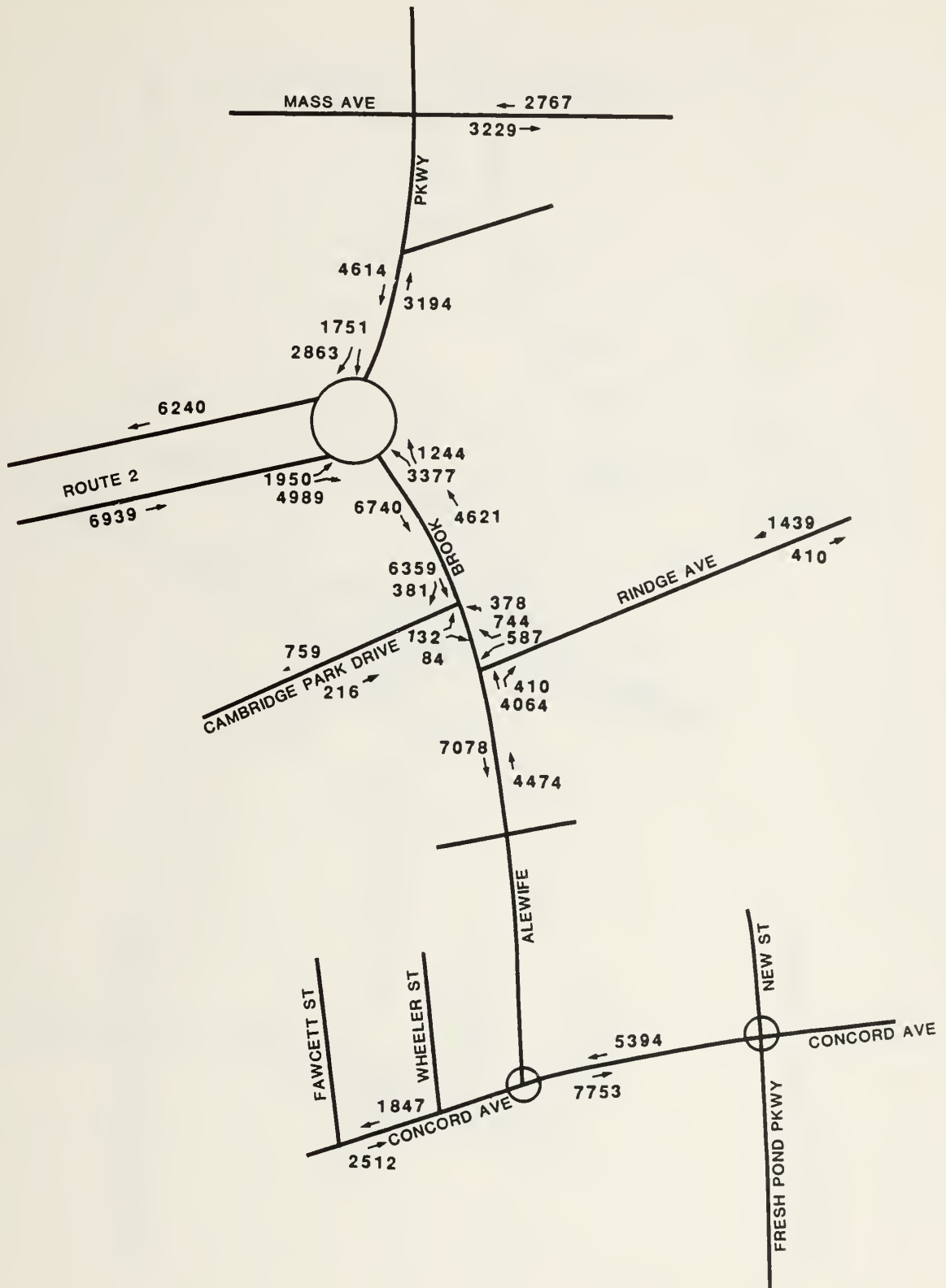
The March 1985 southbound counts on Garden Street look suspiciously low. They imply large increases between then and the next count. There may have been a problem with the counter, but this is not known. A better count might have shown a decrease, or at least a smaller increase, between then and November 1985. Due to directional imbalances in all-day counts at both count locations, and to Garden Street having the heavier southbound, but Mass Ave having the heavier northbound volumes, it appears that some travellers who travel towards Harvard Square on Garden Street use Mass Ave to return later in the day. Thus, it would not have been surprising to see a decrease or smaller increase in the southbound Garden Street before/after counts.

The October 1986 counts show that all-day volumes increased significantly between then and the preceding counts at the Mass Ave count location, but that they remained essentially stable at the Garden Street location. Peak period volumes at the latter did, however, increase significantly. It is unclear what the growth would have been without the extension, but based on continued diversions from Harvard to the new stations as of the Fall of 1986, the growth would probably have appeared slightly higher.

4.4.3 Through-Traffic to Boston/Cambridge

Traffic volumes near Alewife Station were tracked during the course of this study. Counts, consisting of all-day machine, and peak period manual counts, were taken in March 1985, before the station opened, in November 1985, after it had been open for eight months, and finally, in October 1986, after interim access was complete. Figures 4-10 through 4-17 summarize the peak-period counts and show the percentage changes between the first and last counts. Appendix H contains additional tables and maps.

The objective of the counting was to document the changes in traffic volumes in the area over time and to determine the degree to which the station intercepted through-traffic bound for congested Boston and Cambridge. The traffic counts did,



Alewife Before/After Study

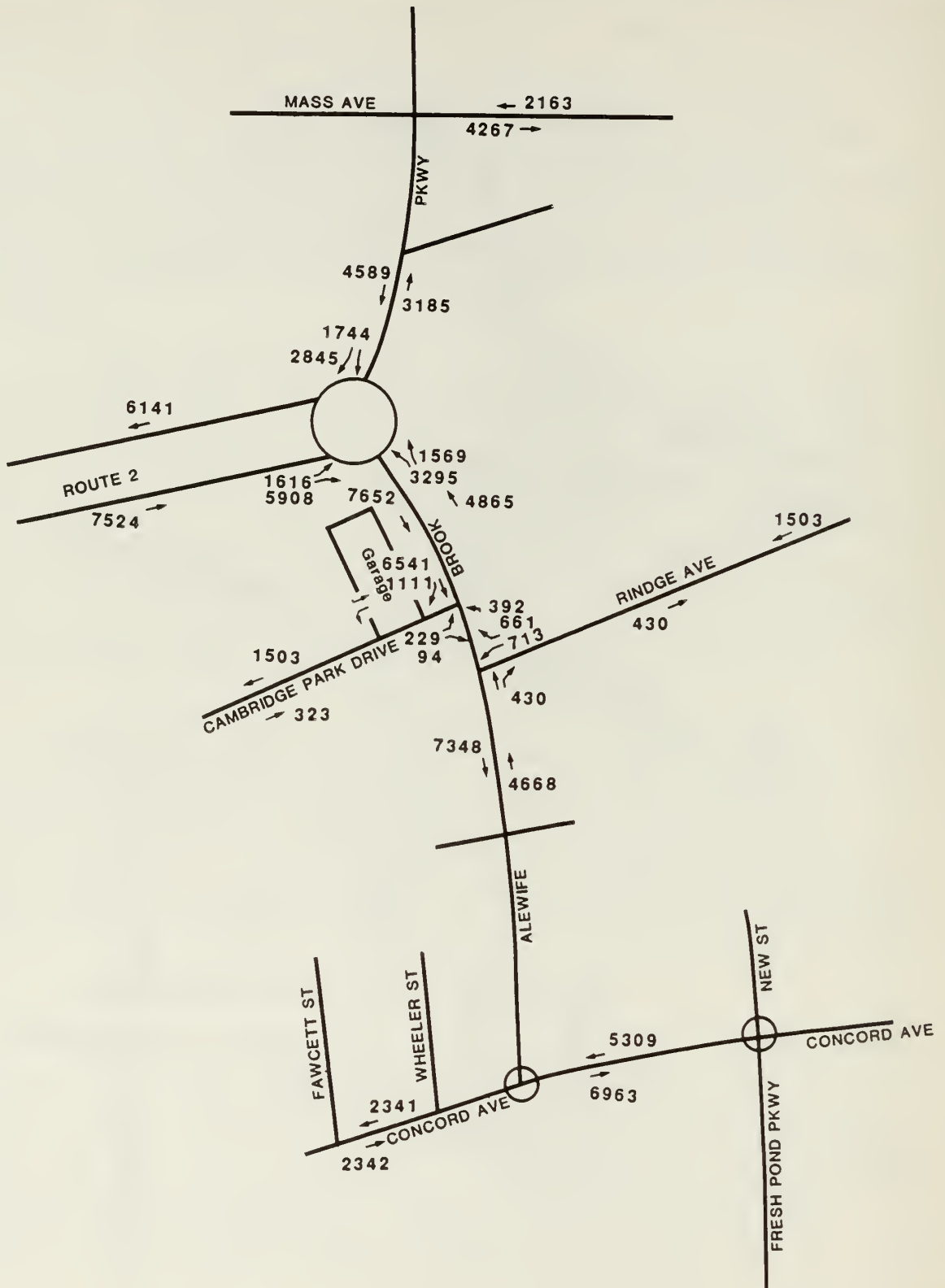
December 1987

Weekday Traffic Volumes
7:00 - 10:00 a.m.
March 1985

CTPS

FIGURE

4-10



Alewife Before/After Study

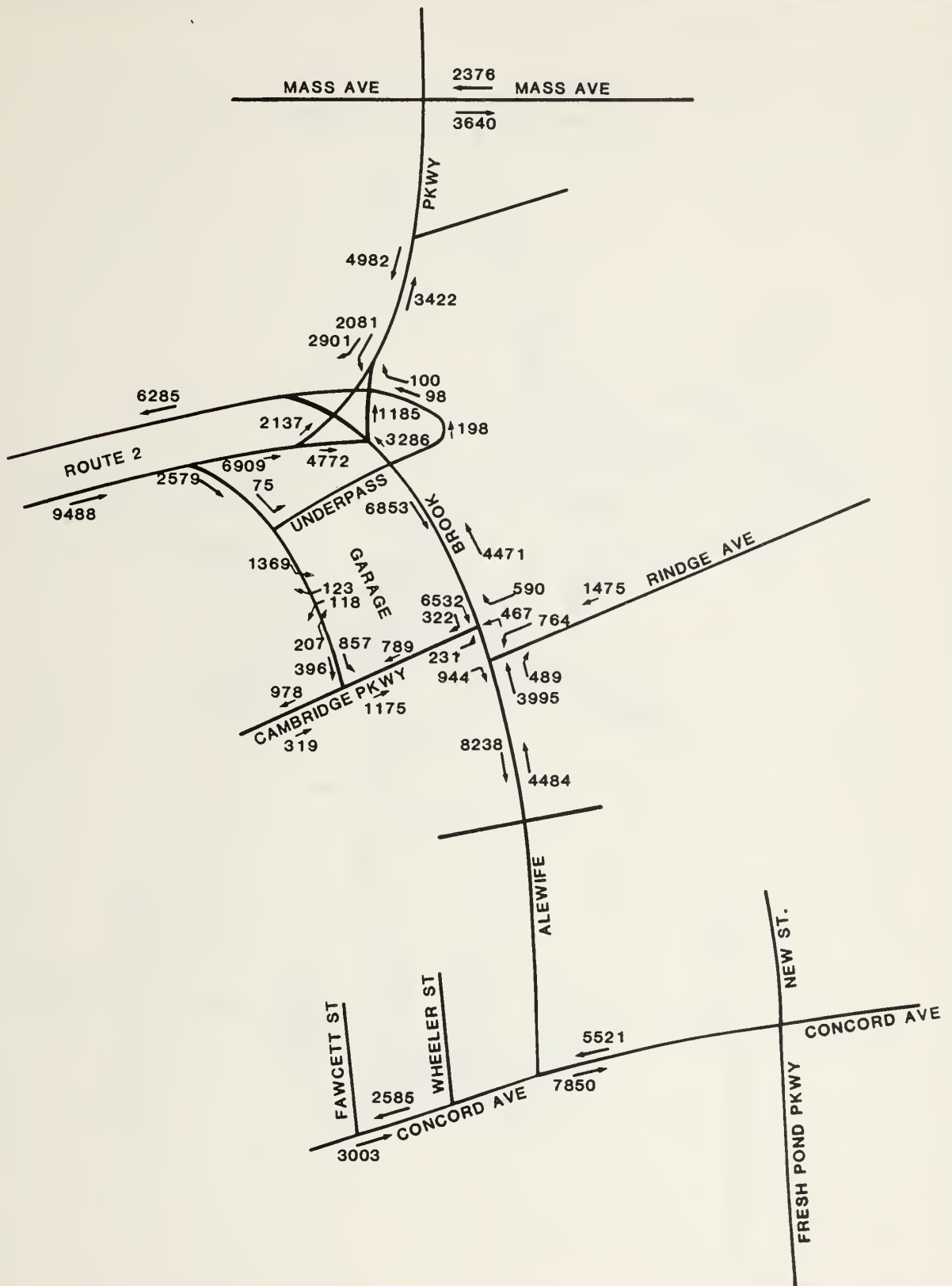
December 1987

Weekday Traffic Volumes
7:00 - 10:00 a.m.
November 1985

CTPS

FIGURE

4-11



Alewife Before/After Study

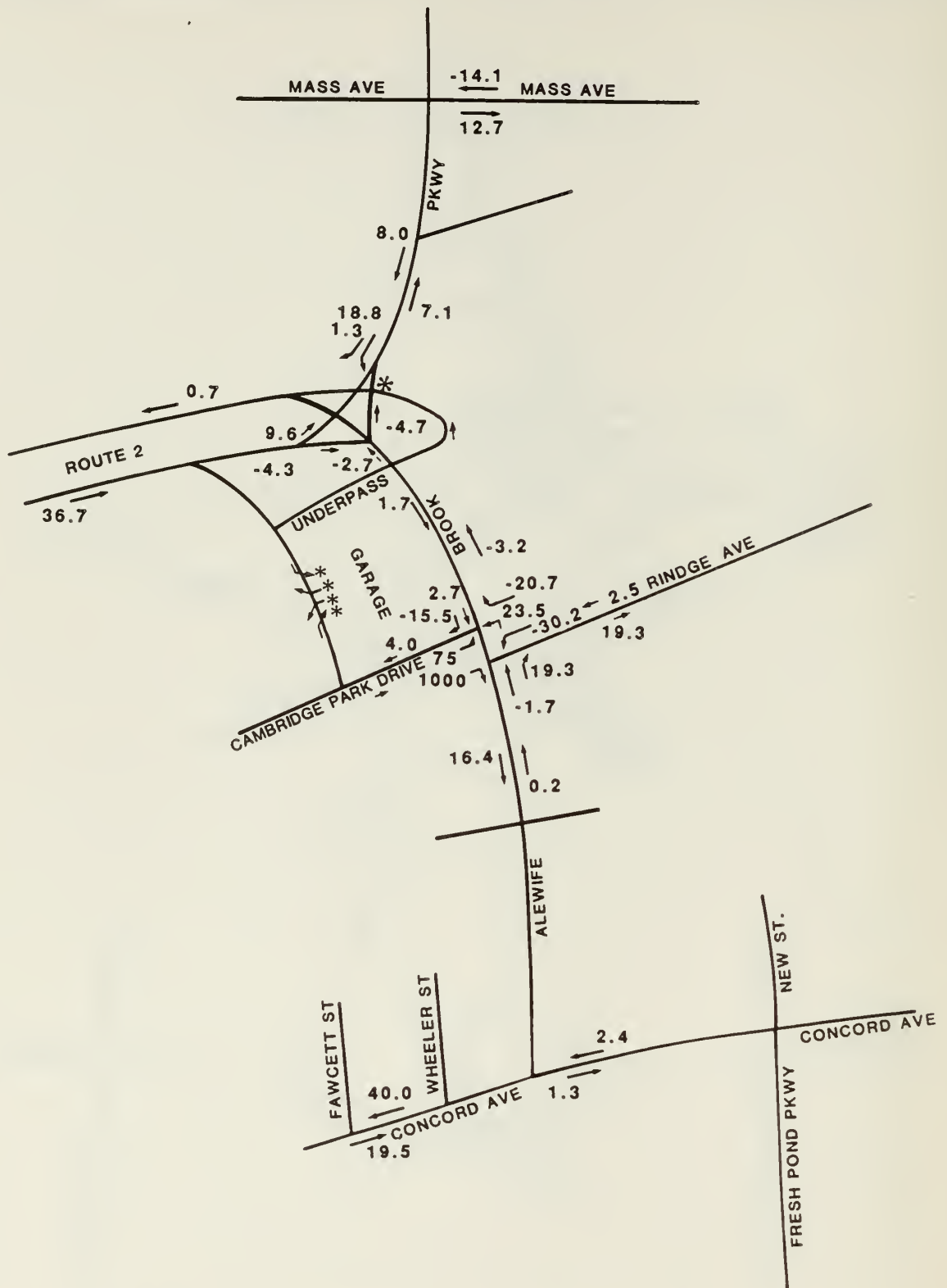
December 1987

Weekday Traffic Volumes
7:00 - 10:00 a.m.
October 1986

CTPS

FIGURE

4-12



* Non-existent, 3/85

Alewife Before/After Study

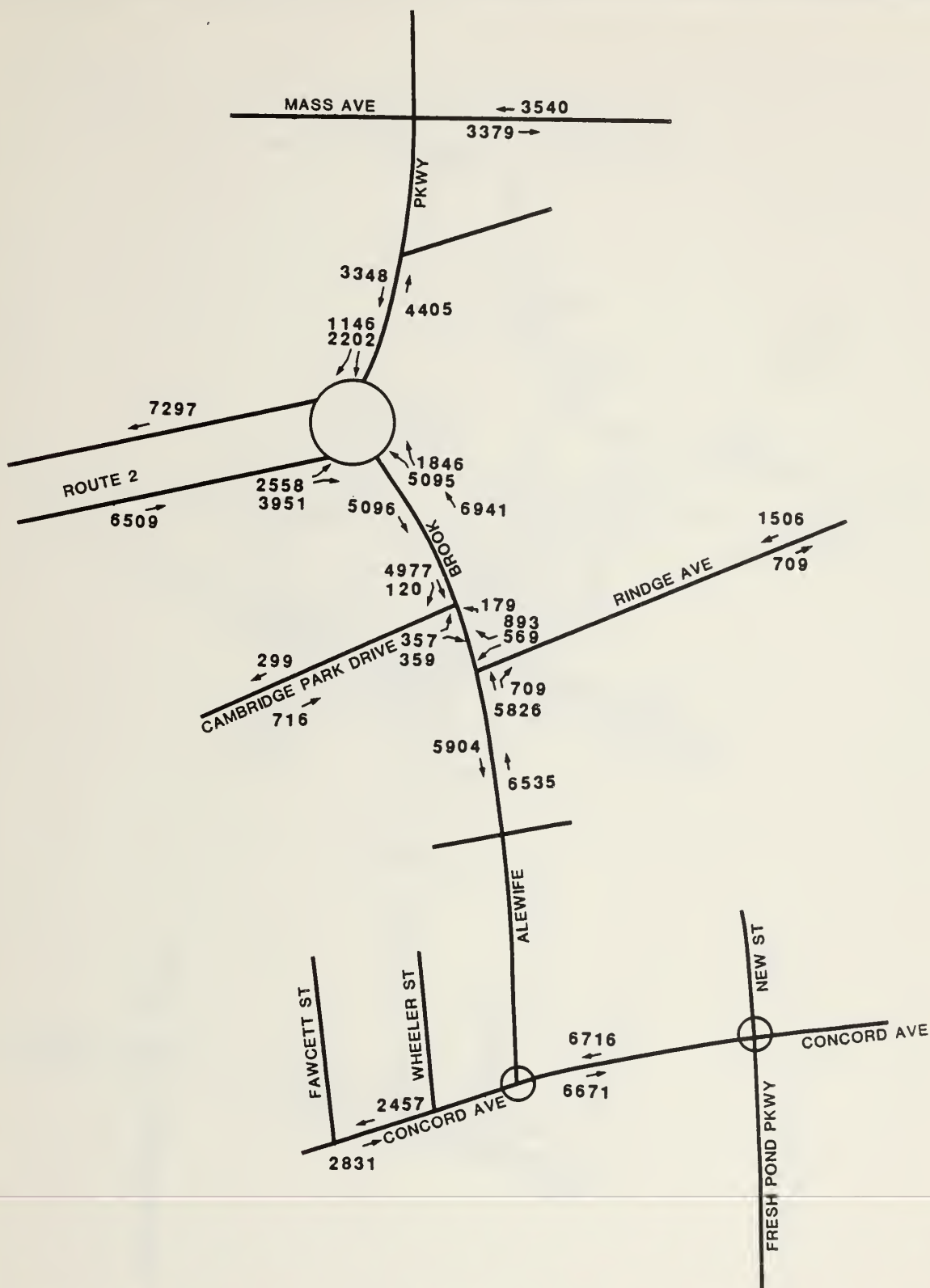
December 1987

Weekday Traffic Volumes
7:00-10:00 a.m.
% Change
From March 1985 to October 1986

CTPS

FIGURE

4-13



Alewife Before/After Study

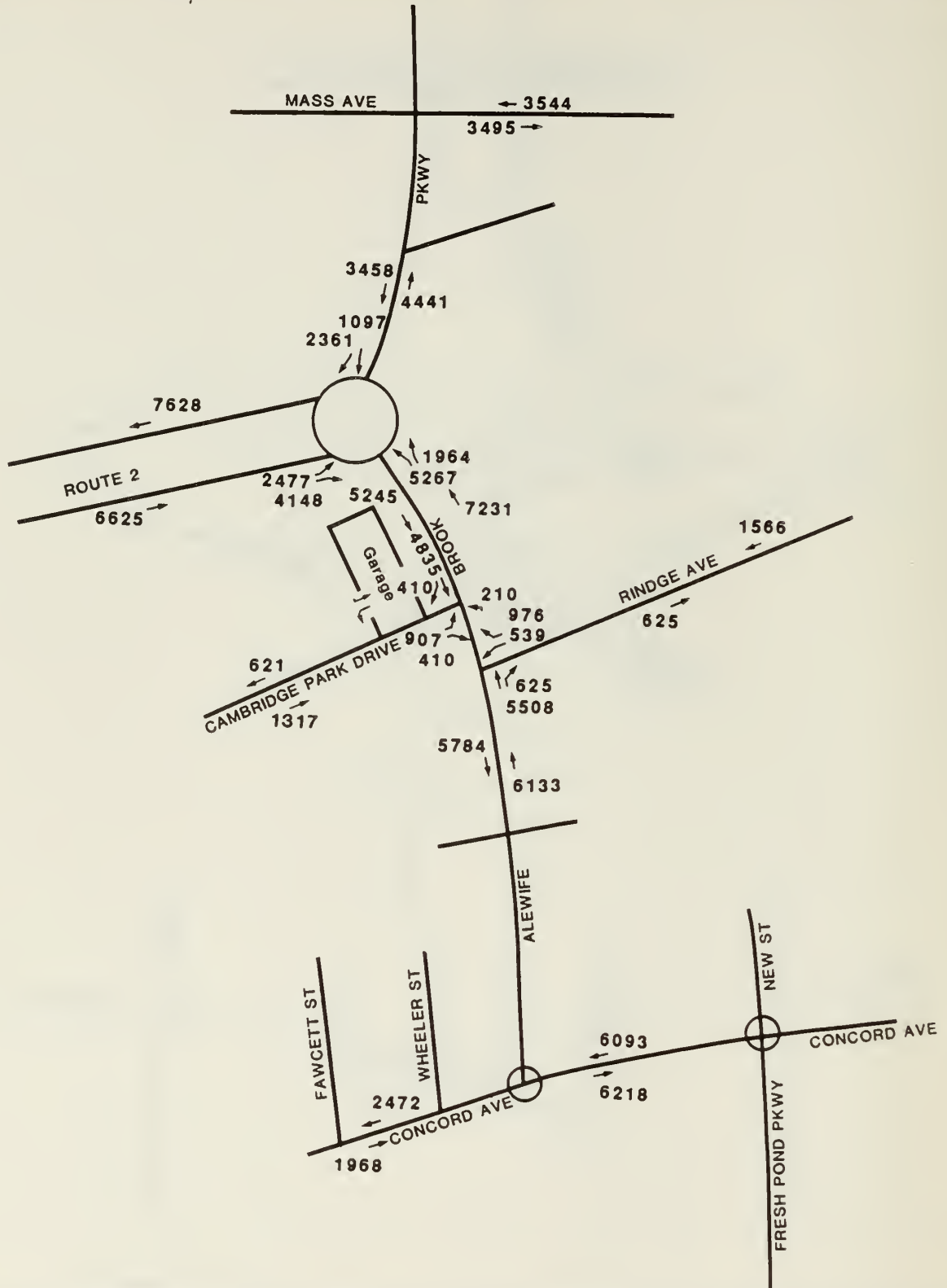
December 1987

Weekday Traffic Volumes
3:30 - 6:30 p.m.
March 1985

CTPS

FIGURE

4-14



Alewife Before/After Study

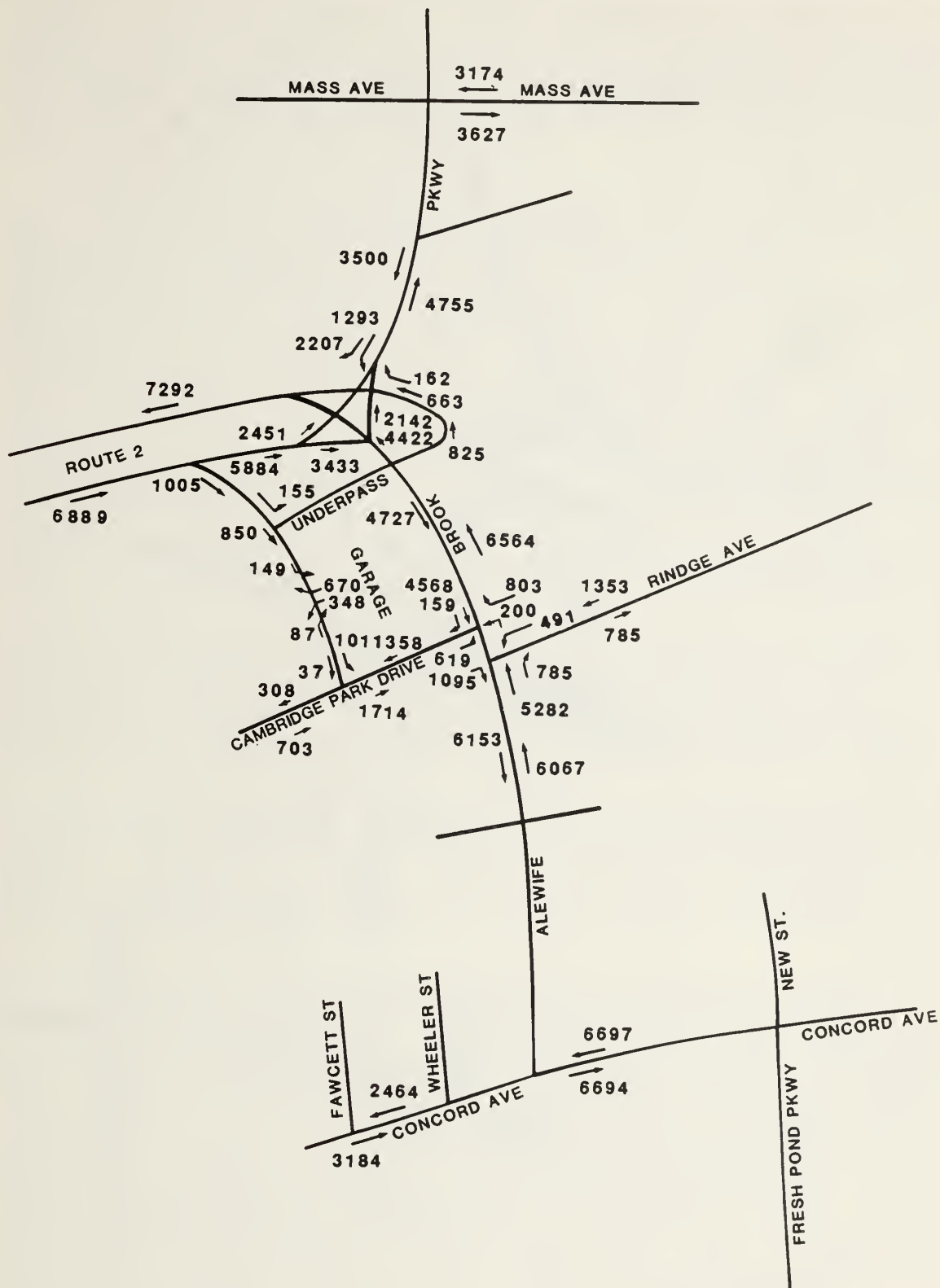
December 1987

Weekday Traffic Volumes
3:30 - 6:30 p.m.
November 1985

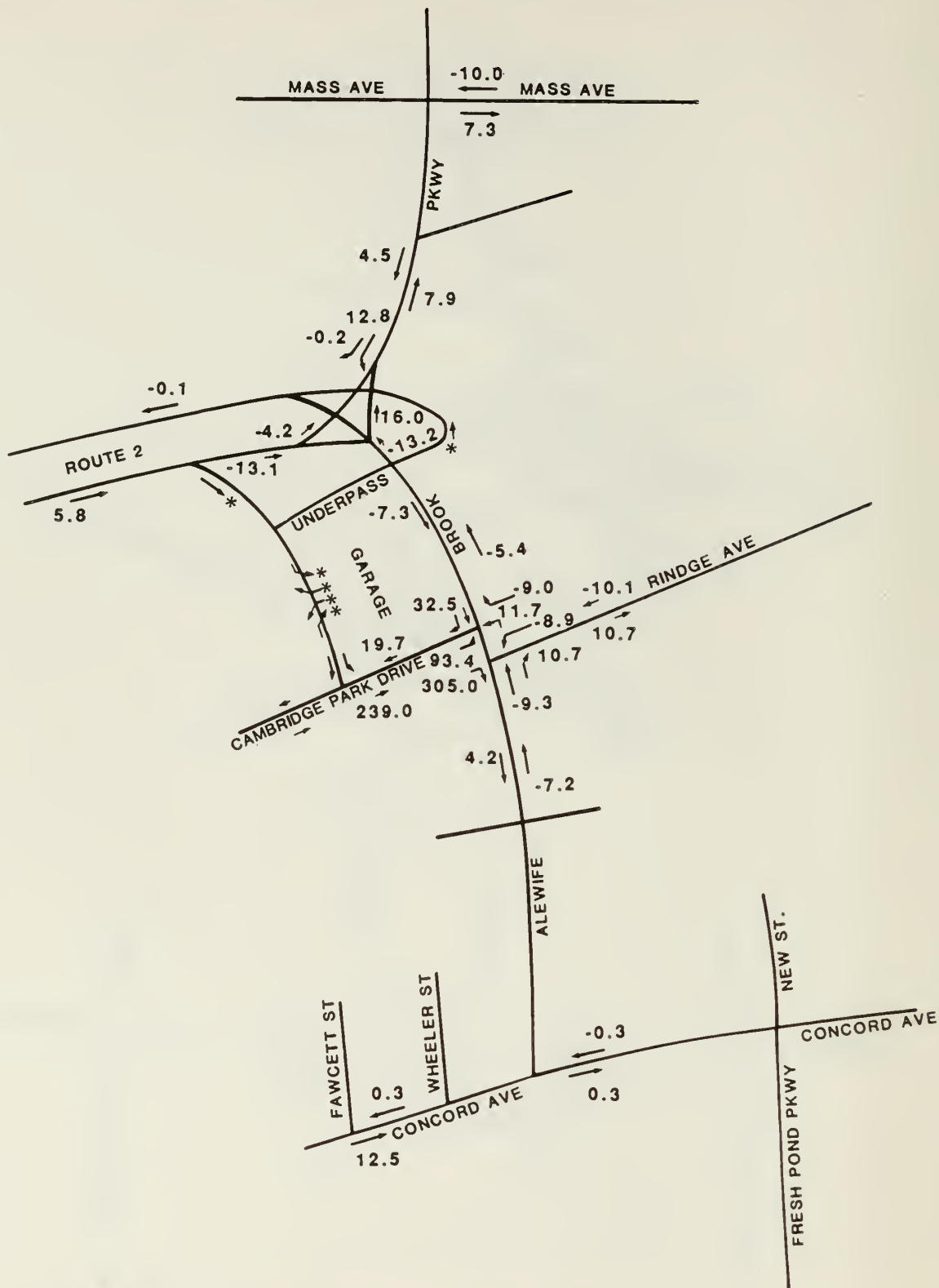
CTPS

FIGURE

4-15



Alewife Before/After Study	Weekday Traffic Volumes 3:30-6:30 p.m. October 1986	CTPS
December 1987		FIGURE 4-16



Alewife Before/After Study

December 1987

Weekday Traffic Volumes

3:30 - 6:30 p.m.

% Change

From March 1985 to October 1986

CTPS

FIGURE

4-17

indeed, document changes in traffic volumes quite well. However, due to secular increases in traffic in the area during the counting period, the counts alone do not indicate the degree to which the station intercepted through-traffic. Therefore, information from the Red Line passenger survey was used to help in assessing this issue.

Within the market of continuing trip-makers who boarded the three new northwest stations between 6:30 a.m. and 6:30 p.m. in the Spring of 1986, 1,048 used to travel by automobile to Boston or Cambridge in approximately 975 autos. The trip behavior of new trip-makers, if the line had never been extended, is somewhat speculative. However, if it is assumed, as in the previous VMT calculations, that this market has the same characteristics governing trip behavior that the market of continuing trip-makers has, then thirteen percent of them, or 628 would have used 582 autos to drive all the way to their destinations. On the basis of further relationships that exist in the continuing trip-maker market, 535 autos were "prevented" from being used to drive into Boston or Cambridge within the market of new trip-makers. Thus, a total of 1,510 autos were actually or theoretically diverted from driving into congested Boston and Cambridge.

Of these autos, 603 were used by continuing trip-makers who now board at Alewife Station who would, in all likelihood, have passed by the station on their way into Boston or Cambridge. Further, 331 more autos, used by new trip-makers, would have likely passed by the station as well.

The traffic counts in the Alewife vicinity do not show a before/after reduction in traffic coming from the north, passing by the station, and going into Boston and Cambridge. Rather, during this period, such traffic in the AM peak period increased by 14 percent consistent with increases throughout the region.

The counts, together with the survey information do, however, provide perspective. Of the roughly 934 autos actually and theoretically diverted from Boston and Cambridge to Alewife Station, 26 percent were diverted during the peak hour between 7:30 and 8:30 a.m. Factoring this Spring survey result up to reflect garage usage as of Fall 1986 results in an estimated 301 Boston/Cambridge-bound autos removed from the parkway going south past the station in the peak hour. This is equivalent to approximately 15 percent of the Boston/Cambridge-bound traffic that passed by the station site during this period in March 1985, just prior to the station's opening. Similar calculations for the entire three-hour AM peak period show a comparable percentage diversion of traffic into the station and away from congested Boston and Cambridge streets.

The diversion to Alewife Station of autos that were not already traversing the area was modest relative to area traffic growth overall. In the AM peak three-hour period, traffic entering the zone around Alewife Station (from all directions) increased by 2,963 or 17 percent between the first and last counts¹⁹ (See Table H-1 in Appendix H). Approximately one-half, or 1,576 of the additional vehicles were bound for the garage either to park or to drop someone off; the other one-half were bound for other locations in the zone or were passing through it. Stated differently, only eight percent of the traffic entering the zone in the AM peak period in October 1986 was bound for the garage; 92 percent was not. However, since 411 autos belonging to continuing trip-makers, and another 226, belonging to new trip-makers would have been passing through on the way to Boston and Cambridge in the AM peak period if the extension had not been built, the actual new AM peak traffic into the area due to the station was 939 autos (1576 - 411 - 226). Thus, the station led to a 5.3 percent increase in traffic into the area.

Route 2 eastbound was the major approach used to the garage in the AM peak period, accounting for 87 percent of all vehicles bound for it. Only 84 or five percent of the garage-bound vehicles approached from Alewife Brook Parkway southbound. These vehicles represented less than two percent of the southbound traffic on this link. Similarly, 123 or eight percent of garage-bound vehicles approached from the south and east on Alewife Brook Parkway northbound and Rindge Avenue westbound. Again, these vehicles made up only about two percent of the traffic using those roads in those directions.

The ramps built between the garage and the Route 2/Alewife Brook Parkway intersection, in addition to serving garage patrons, have relieved nearby intersections of some traffic. Of the 2,579 vehicles that exited Route 2 onto the eastbound ramp in the AM peak period, only 1,369 entered the garage, leaving 1,210 that continued on to other destinations. Of these 1,210, 75 used the ramp system to bypass the Route 2/Alewife Brook Parkway intersection in going north on the parkway. Another 396 used the ramp to bypass that intersection and the Alewife Brook Parkway/Cambridge Park Drive intersection to get to destinations on Cambridge Park Drive. The remaining 739 used the ramp to bypass the Route 2/Alewife Brook Parkway intersection to continue south on the parkway.

¹⁹ This zone is the area around the station that is entered by Route 2 eastbound, Alewife Brook Parkway northbound and southbound, and Rindge Avenue westbound.

A final observation concerning AM peak period traffic volumes in the Alewife vicinity is that traffic growth into the zone accelerated toward the end of the counting. Between March and November 1985, traffic grew at a rate of .6 percent per month, while between November of that year and October 1986, it grew by one percent per month. This acceleration in traffic growth coincided with accelerated use of parking at the garage.

Traffic growth in the zone, both with and without garage-generated traffic, was more modest in the PM peak period (See Table H-2 in Appendix H). Total traffic exiting the zone in the period grew by one percent between March and November 1985 and by three percent between November 1985 and October 1986. Volumes increased by four percent between the first and final counts. Excluding garage traffic, volumes actually decreased by two percent between the first and final counts.

If it is assumed that the portion of garage traffic that would have traversed the area in the absence of the station is the same in the PM peak period as in the AM peak period, then 600 vehicles exiting the garage are new to the area and, therefore, station-generated traffic represented a 3.3 percent increase in PM peak period traffic in the area over March 1985 levels.

During the PM peak period, most garage-generated traffic travelled away, rather than toward, the garage as one would expect. A total of 1,018 vehicles exited the garage, while 236 entered it. Of the exiting vehicles, 670 or 66 percent left via the ramps into the Route 2/Alewife Brook Parkway intersection; the other 348 left via Cambridge Park Drive. Of the former, 663 headed west on Route 2. Nearly all of the 348 vehicles that left via Cambridge Park Drive turned south on the parkway, as one would expect.

With the exception of Cambridge Park Drive, traffic entering the Rindge/Alewife Brook Parkway/Cambridge Park Drive intersection decreased in the final count. The southbound parkway reduction is explainable by autos being diverted by the ramp and then approaching the intersection from Cambridge Park Drive. As for the reduced volumes northbound on the parkway and westbound on Rindge Ave., it may be that some travellers are now avoiding the area for one reason or another. Perhaps they found alternate routes during reconstruction of the intersection and did not yet reappear in the final count which was taken only weeks after completion of the work.

One route these diverted travellers seemingly did not shift to in the PM peak period is Concord Avenue westbound. The counts there remained essentially stable between March 1985 and October 1986.

The new ramp system, in addition to providing a convenient means of accessing the garage, also aided traffic flow in the area. The ramps diverted 670 vehicles that would otherwise use the Rindge/Alewife Brook Parkway/Cambridge Park Drive intersection and the stretch of Alewife Brook Parkway northbound between the two study intersections. This number is equivalent to 39 percent of the volumes approaching the intersection from the west and to ten percent of the vehicles recorded on this stretch of the parkway in the final count. Since, before reconstruction, this intersection and the northbound stretch of the parkway had significant queues, the removal of these vehicles was beneficial.

5 SUMMARY OF MAJOR FINDINGS

Red Line Ridership as of Fall 1986²⁰

- Daily boardings at all four stations totalled 33,500.
- Daily boardings at Harvard were 18,700, of which 14% or 2,600 were in the outbound direction.
- Daily boardings at the three new stations, including those diverted from Harvard, totalled 15,000.
- Daily boardings at the four extension stations totalled 12,530 more than at Harvard alone prior to the extension. This translates into 19,900 new passenger-trips on the Red Line due to the extension.
- Boardings at Harvard alone have declined, and will likely continue to do so in the near future, as travellers continue to divert to the new stations.
- During the first two years of operation, boardings at the three new stations increased at a faster rate than experienced in a similar time span by most new extensions opened by the MBTA since 1970.

Before/After Trip Behavior (Three New Stations)

- At the new stations, 35% of boarders are continuing Red Line users; 65% are making new trips on the Red Line.
- Split further, 35% are continuing users, 30% are new to the Red Line and used to make the same trip by other means, and 35% are new to the Red Line and did not previously make the trip they were making when surveyed.
- Among continuing trip-makers (former Red Line Users and those who made the trip by other means), 85% formerly used public transportation; 15% did not.

²⁰ These figures include an estimate of night boardings that would have occurred in the absence of evening track reconstruction/substitute busing which was occurring at the time.

Continuing Red Line Users:

- 44% changed their mode of access to the Red Line. Use of park & ride doubled from 300 to almost 600, kiss & ride increased three-fold from almost 100 to 300, and walking increased by a factor of 2.5 from almost 900 to 2,100. Conversely, feeder bus usage among these travellers is half what it formerly was (from 3,500 to 1,800).
- Predominant access modes are: walking (44%) and feeder bus (37%).
- The single largest shift among those who shifted access modes was from bus to walking (60% of those who shifted).
- 91% of continuing users formerly boarded at Harvard. The other 9% boarded at Central (6%), and Kendall and Charles (3%).
- Frequency of use increased slightly. Those travelling on the line 5 or more days increased from 52% to 57%.

New Users Who Previously Made the Trip by Other Means:

- This group is nearly as large (only 750 less) as the continuing user group.
- Predominant access modes are: walking (46%), park & ride (28%) and feeder bus (19%). This group uses park & ride more, and buses less, than continuing Red Line users.
- Major previous primary modes were: line-haul bus (37%), automobile drive-all-the-way (28%) and Orange/Green Lines (22%). Among the latter, 78% used feeder buses to access the rail lines.
- Stated differently, two-thirds previously used transit; one-third did not.
- The single largest mode-to-Red Line access mode shift was from line-haul bus to walking to the Red Line.
- A net of 190 fewer individuals now make auto-involved trips (which includes drive-all-the-way, park & ride, and kiss & ride), although the majority (55%) of those who previously used an auto in their trip still do.

New Users Who Did Not Formerly Make Trip:

- The group is precisely the same size as the continuing user group.
- The predominant access mode is walking (61%). These travellers walk relatively much more than the previous groups of continuing trip-makers.
- Most did not start making trips anew because of the Red Line; most moved into the area, changed jobs, started school or work, etc. In other words, most would have made their trips in the absence of the extension; some would have used the Red Line at Harvard, some would have driven to their destinations and some would have taken buses, etc.
- The greatest number of new trip-makers board at Davis (1,820), followed by Porter (1,639) and Alewife (1,373).

Bus Ridership On 15 Routes Impacted by Extension

- Ridership fell off by 7,340 trips per day or by 15% due to shifts to the Red Line.
- Bus transfers to the Red Line fell off by 2,200 per day or by 18% as travellers shifted to walking, driving or kiss & riding to the Red Line.
- Routes whose major function has always been as feeder service experienced an increase in bus/Red Line transfers (by 980) and a decrease in local riding (by 610). Some transferees are new to the buses and the Red Line, and some are local trip-makers who are now forced to transfer in order to complete their trips.
- Productivity decreased slightly on these routes as bus service increased and patronage decreased. Twelve fewer peak buses are used, but the remaining 73 buses are operated over more service hours. Passenger trips per vehicle remained stable, but passengers per hour decreased 16%.

Park & Ride Usage

- As of the Spring of 1987, average garage use exceeded 1,700 vehicles per weekday.
- At its daily peak, the garage is approximately 75% full.
- Use of Alewife garage has increased steadily since its opening, by an average of 60 vehicles per month.

- The market area for Alewife park & riders overlaps those for Lechmere and Sullivan Stations somewhat. As of April 1986, approximately 10 autos were diverted to Alewife garage from Lechmere and 50 were diverted from Sullivan.

Variable Operating Costs and Revenues

- The passenger revenue/variable operating cost ratio for the Red Line extension and the reconfigured corridor bus routes together remained stable before and after the extension, at approximately .47.
- The passenger revenue/variable operating cost ratio for the extension alone was .62 compared to a 1984 MBTA rapid transit system average of .51 (the last year for which a figure is available).
- The passenger revenue/variable operating cost ratios for the bus routes that existed before and after the extension increased or remained constant for six and decreased for eight. Their combined "after" ratio was .40 compared to a 1984 MBTA bus system average of .38.
- Daily variable operating costs for the extension (in \$1984) are about \$16,300.
- Daily variable operating costs for the 15 buses impacted by the extension decreased slightly (in \$1984) from \$37,400 to \$36,900.
- Total variable operating costs for the services considered, in the Fall of 1986 were, then, \$53,100 (\$1984).
- Combined Red Line/bus passenger revenue in the Fall of 1986 was \$24,800.

Red Line User Characteristics (All Four Stations)

Socio-economic and Trip Characteristics:

- The "typical" Red Line user is 35 years old, lives in Cambridge, works in Boston, uses the Red Line 3 to 4 days per week, has a car available for the trip but used the Red Line instead, and has a household income over \$30,000 per year.
- Among continuing trip-makers, door-to-door travel time decreased significantly, from 52 to 43 minutes, resulting in a daily travel time savings of 2,200 person-hours.

- Transit dependency is relatively low: 54% of boarders had a car available for their trip. Alewife boarders are least transit dependent; Davis and Porter, the most dependent.
- 45% have household incomes greater than \$30,000 per year.
- Most riders (58%) are between 18 and 34.
- Most riders at Davis and Porter live in Cambridge and Somerville, while most at Alewife live in Arlington, Lexington and other towns northwest of Alewife Station.
- Most riders are bound for Boston or Cambridge (58% and 21%).
- Most riders at Davis and Porter walk (66% and 76%, respectively) or take a bus (21% and 13%) to the stations, while most at Alewife park & ride or take a bus (38% and 36%).

Attitudes:

- The appearance of the new stations was the highest rated attribute of service, with 93% of passengers rating it as good to excellent.
- 75% of passengers rated MBTA employees, cleanliness of trains, ride comfort, appearance of new stations and directness of service as average or better.
- 62% rated reliability as average or better, and 71% rated crowding conditions as average or better.
- New Red Line riders rated service more positively than continuing riders.
- Most comments made on surveys were negative in nature, which is typically the case in surveys of this sort. The concerns most often cited were for: greater Red Line reliability, less crowded trains, better public information, cleaner stations, and more reliable escalators.

Other Characteristics:

- The three most common reasons cited for using the Red Line extension were: avoidance of parking (48% of survey respondents), avoidance of traffic (46%), and no car available (38%).
- 25% of survey respondents made a change in their home, work, or school locations; in their shopping habits; in their work hours or auto ownership, due to the extension.

Changes in Automobile Vehicle-Trips

- Growth in weekday corridor VMT was slowed by 5,700 (one-way) due to travellers diverting from driving all the way to their destinations, and due to continuing auto users making shorter trips (to the Red Line instead of all the way into town). This figure represents a 23% reduction in the VMT that would have been attributable to the travel markets measured in the absence of the Red Line extension.
- Among continuing and new trip-makers combined, an estimated 1,640 one-way auto trips were shortened or foregone altogether (or "prevented", in the case of the new trip-makers). Conversely, 1,309 more one-way auto trips are now used in park & riding. Thus, there was a net reduction (and "prevention") of 336 auto trips in these markets.
- 1,510 of the diverted one-way auto trips were diverted from congested Boston and Cambridge.
- Traffic growth into Harvard Square was slowed due to 643 autos being diverted from there to the three new stations.
- AM peak three-hour traffic into the Alewife Station vicinity increased by 2,963 or 17% between Spring 1985 and Fall 1986. Only one-third of the increase was attributable to garage-bound vehicles that were diverted into the area from elsewhere (637 vehicles now using the garage would have passed through anyway, on the way into Boston and Cambridge).
- 87% of the vehicles bound for Alewife Station in the AM peak period approach from the west on Route 2 and consequently use the Route 2/garage ramp system.
- Significant numbers of autos (1,210 in the AM peak period), use the Route 2/garage ramp system to avoid the Route 2/Alewife Brook Parkway intersection.

6 CONCLUSIONS

A comprehensive collection and examination of information was undertaken in order to judge the impacts of the Red Line extension to Alewife. It is anticipated that the findings of this effort will aid in future planning efforts, as well as in an immediate understanding of who uses the line, where they came from and why they use the line. In addition, various questions have arisen, on the subject of traffic volumes for instance, that the reported findings will help to answer.

It must be stressed that the findings in this report represent near-term conditions on the line. In a few years, the level and composition of ridership will presumably be different; it will have reached an "equilibrium" state. However, several concluding observations are in order.

First and foremost, the Red Line extension very clearly affected the travel patterns in the Northwest Corridor, and it did so in ways that were overwhelmingly positive. Travellers' access to the rapid transit system was enhanced greatly and the majority of those who changed their travel behavior are now saving time and money. The region as a whole benefited from the new service in various ways, the most readily measurable one being a reduction in automobile traffic. Significantly, the MBTA was able to provide this improved transit service to the corridor at the same level of cost-effectiveness as it had provided the previous service.

Ridership on the extension, in its first twelve to eighteen months, has risen steadily and should continue to do so. It has already risen at a faster rate than ridership on other extensions opened by the MBTA in recent years, but based on experience with these other extensions, it has not yet had time to realize its full ridership potential.

In addition, other factors will likely contribute to further growth on the line. Urban area parking and highway capacity is not keeping pace with the growth in travel demand, thus making the line an increasingly attractive travel option. Specifically, much of this growth in the next few years will be in downtown Boston and Cambridge, the major destination markets for the line. New Red Line equipment, which is currently on order, should also have a positive

impact on ridership, based on experience with other MBTA services.

The line increased access to rapid transit for many people in various ways. The addition of 2,200 parking spaces greatly enhanced auto access to the line and thereby increased the geographic extent of the Red Line market. The use of Alewife garage has increased steadily since its opening, and available evidence suggests that it will continue to do so in the near future until full. At its peak, it is already approximately 75 percent full.

The fact that the extension was built through compact, densely settled areas and is, therefore, physically closer to more people, implies that walk access to the line has increased. Indeed, most of the people new to the line who are making trips anew, walk to the line. Others who previously had to make two-seat rides (bus to Red Line) now can walk and make a one-seat ride, and save money at the same time.

The bus network serving the Red Line was reoriented in such a way that it increased access to rapid transit as well. Although ridership on the buses decreased, with a consequent decrease in productivity, this was expected and should not be alarming. The market of bus users would be expected to increase more slowly than others for a variety of reasons. First, it takes time for people to find out about new bus service. Many people may not yet realize that a nearby bus route now goes to a nearby station. Moreover, an increase in auto and walk access occurred immediately, and with immediate market shifts, as soon as the line opened. The buses already largely existed though; most users of them were already on them, and attracting new patrons would be expected to take more time. All of this suggests retaining present levels of service for now.

The fact that one-third of continuing trip-makers who were attracted to the three new stations were previously using non-transit modes is heartening. It is precisely consistent with conventional wisdom regarding the impact that new transit lines have on travel behavior. Moreover, these diverted travellers include those diverted from autos.

In addition to those who were taken out of their cars, many who still use autos now travel shorter distances in them as they access the Red Line. As a result of these changes, overall VMT growth in the region was slowed, and autos were removed from congested Boston and Cambridge. Harvard Square, specifically, experienced a documented reduction of over 600 cars, as well as 122 buses per weekday, relative to what it would have experienced without the extension.

The Alewife area, on the other hand, experienced an increase in auto and bus traffic due to the extension. Much of the traffic destined for Alewife Station would, however, have been traversing the area anyway, as auto travellers drove to destinations in Cambridge and Boston and as buses traversed Route 2 on their way to Harvard Square. In addition, the reconfigured Route 2/Alewife Brook Parkway intersection includes ramps which not only enhance access to the garage, but allow many autos to bypass the intersection, thereby spreading all traffic more thinly.

